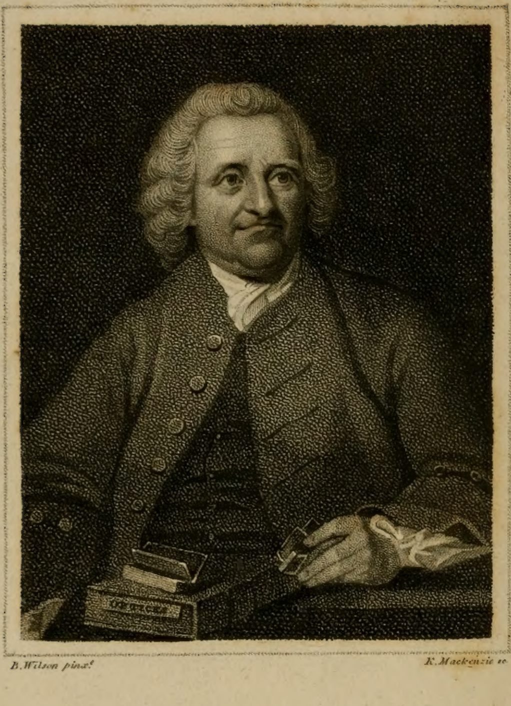

B. Wilson pinx.t K. Mackenzie sc.

John Dollond F.R.S.

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THE
PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, &c. &c. &c.

" Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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THE

PHILOSOPHICAL MAGAZINE.

I. *Facts illustrative of the Shrinkage and Expansion of Cast Iron, &c. &c. By* DAVID MUSHET, *Esq. of the Calder Iron Works* *.

THE high temperature requisite to melt cast iron has prevented the chemical and philosophical world in general from becoming acquainted with many of its habitudes and peculiarities in the different stages of manufacture. Those engaged in foundries are frequently prevented, from the hurry and bustle which attends manufactories, from making observations, and acquire no habit of detailing them. Others again, from their earliest infancy, have been accustomed to observe, that certain appearances, time out of mind to them, had always followed certain actions performed. They acquire a laconic habit of reasoning; and if asked how such appearances are to be accounted for, their answer is, "They must exist so and so—it is in the very nature of the thing."

It is difficult to conceive a more ample field for observation than an extensive foundry. Combination, change, decomposition, combustion, and deflagration, are constantly performing their respective parts, and continually presenting matter under new and interesting appearances.

Elementary substances, subject to no real change, are modified in a variety of ways by the alternation of heat and cold. The laws which govern these are constantly exerted to produce effects equivalent to the exciting cause; and, while we often remain heedless spectators, these unerring operations are productive of phænomena which frequently elude our sagacity or puzzle our judgment.

The subject of contraction and expansion appears simple, and the presence or absence of caloric alone in the body operated

* Communicated by the author.

operated upon frequently explains, in a most satisfactory manner, the whole minutiæ.

But this regards only the heating of certain substances in temperatures short of fusing them. When the object of experiment is exposed to a heat sufficient to fuse it, it then becomes subject to new laws as a fluid, and exhibits phænomena entirely different. By not taking the change of state from that of a solid to a fluid into the account, some writers have given an awkward and unsatisfactory account of the laws which regulate iron in these two different states. Before I proceed to detail some experiments made upon this subject, I shall trace out the different states of shrinkage and expansion, as observed in cast iron.

In doing this I shall divide shrinkage into two distinct operations: 1st, Shrinkage, properly so called, when a mass of iron diminishes or shrinks within itself, and would actually displace a smaller quantity of water, and when no degree of heat short of fusion would make it occupy its former bulk or volume. 2d, Contraction, or that diminution of superficial measurement which any body undergoes by evolving its caloric. The surface in this case is never injured; the casting will be found less than the pattern from which it was formed, and simple heating will restore it to its greatest original volume.

The former of these properties cannot exist without the latter, but this last may take effect in full force in many minor operations without any appearance of shrinkage. I only say appearance; for I believe, abstractly speaking, the one never takes place without the other, though in such various minute degrees that it is often difficult to form any estimate of the quantity.

In casting pieces of ordnance we are enabled to judge of the conjoint effects of shrinkage, contraction, and expansion. We shall suppose that a gun mould of any given length is filled with fluid cast iron not subject to these laws; then the size and shape of the gun, when cold, would exactly correspond to the dimensions of the mould. But finding that the piece of casting was considerably altered, that it had shrunk interiorly, was diminished in point of length, and had lessened its diameter, we must seek for a solution of these facts in the explanation of the causes respectively.

First assuming, what shall be hereafter proved by direct experiment, that cast iron occupies less volume when fluid than when solid; that in the act of the arrangement of the moleculæ towards consolidation, it occupies a larger bulk than

than at any other period; and that, when cold, and in proportion to the absence of heat, so will the volume of the metal be diminished.

1st, then, *Shrinkage* appears to be dependent upon two causes; the gravitation of the fluid metal, and the expansion of the mould. The latter, I conceive, acts a very powerful part: the immense quantity of caloric combined with the iron is in part easily and almost instantaneously communicated through the sand to the iron box: this creates a disposition to expand, in which it is greatly assisted by the great pressure of fluid iron. That portion of the metal in contact with the interior of the mould is the first to lose its fluidity, and is acted upon and forced to give way in the same ratio of expansion before the subtle and denser fluid. The diameter of the shell of the gun is at this period increased in every part; the fluid iron in the interior descends to occupy the enlarged space, and the head of the gun presents an increasing chasm like the concave of a sand glass. In proportion as the cast iron resolves itself into a solid, a diminution of pressure should take place upon the mould: this would inevitably follow, were not its force replaced by the increased volume of the metal passing into a solid state, which is equivalent to that law which I have termed

2d, *Expansion*. Of the extent of this operation we may judge from the following facts:—All patterns of castings are made somewhat larger than the piece of goods is wished to be: in common cases 1-8th of an inch to the foot is allowed, but in many cases the allowance will be nearly 3-16ths of an inch. In the case of the gun, therefore, the mould would be plus the allowance upon the pattern what space was gained by beating the pattern to loose it from the sand, and all the extra space acquired by the increased volume of the consolidating iron. These, taken collectively, may amount to 1-4th or 5-10ths of an inch; and so much less will the diameter of the gun be found when cold, to what it would have measured at the climax of its expansion.

3d, *Contraction* immediately takes place of the metal ceasing to expand: to its effects are chargeable the reduction of the increased diameter of the gun, and which seems merely in consequence of the escape of the caloric.

The action or effect of these separate laws will intimately depend upon the quality and fluidity of the metal: with the same quality of iron different effects will be produced according to the division of the fluid, and with the same degree of division in the fluid the extent of the operation of these laws will be different with the different qualities of

crude iron. Soft cast iron very hot will shrink and contract less than iron equally hot but of a harder quality, or, which is the same thing, than iron containing less carbon.

In casting cylinders, pipes, and other hollow machinery, the effects of expansion and contraction are manifested without any great degree of shrinkage appearing.

The diameter of the mould in all these castings is generally made from 1-8th to 3-16ths per foot in diameter larger than the casting is wished to be; while the space or vacuity left betwixt the exterior and interior of the mould, called the thickness, is made less than the strength in metal is wished to be.

When the cylinder is cold, however, the diameter, if properly allowed, will be found correct by the operation of contraction in cooling; while the thickness in metal will be found increased, though still correct, by an expansion or separation of the exterior and interior parts of the mould. This last is by the moulder called *straining*; and if great care is not taken to compress the sand firmly round about the mould, the thickness is sometimes increased so much as to render the manufacture unsaleable. Should this necessary precaution be slightly performed, and the thickness considerably increased, the usual expansion which takes place when the metal passes into the solid state becomes so extensive as to effect a permanent increase of the diameter of the casting, and destroy its use *. The united effects of these two causes force the sand to assume an elevated posture all round the mould, and occasion violent rents and fissures, which become immediately filled with pale blue flame, accompanied by a crackling noise like the snapping of electric matter.

Shrinkage in these castings, particularly if large, would affect the solidity of the vessel by taking place to a considerable extent upon the upper surface, immediately where the runner discharges the metal into the mould. This is in a great measure counteracted by feeding these *gates* or *runners*, after the mould is filled, with several ladles full of fluid iron, and keeping the communication open to the edge of the

* The additional thickness always takes place to the exterior of the mould. The pressure can more easily act with effect against the concave than the convex side of the mould. The moulder is fully aware of this in the act of cooling, particularly if the metal has been very hot and of a sharp quality. After he conceives the iron fairly consolidated throughout, he cuts two openings at least in the core or interior part of the mould, and penetrates to the red-hot surface. This gives scope to the contraction of the vessel, and preserves the casting frequently from being destroyed.

casting

casting by moving small iron rods up and down in the *gate*. The metal is thus allowed to percolate into the chasm, if any is formed, and prevents any bad consequences likely to ensue from the general shrinkage of the mass.

It is impossible to convey an exact idea of the extent or quantity of shrinkage that takes place in castings, or proportion it to the weight or dimensions of the original mass. The subject of contraction is more within the reach of measurement, and in many cases may be ascertained with great precision.

The following bomb-shell gauges were cast from very clean wood patterns; the breadth of metal in the hoop was exactly 1·250 inches, and the thickness ·450 inch.

	Diameter of Patterns.	Diameter when cast.	Contraction.
1st Pattern	7·500 inches.	7·350 inches.	·150 inch.
2d ——	5·950	5·850	·100
3d ——	5·500	5·430	·070
4th ——	4·550	4·490	·060
5th ——	4·060	4·020	·040

The relative proportion of contraction to the diameters will be as follows:

Contraction of No.	I. ·15,	equal to	1-50th of the diameter.
	II. ·10,	——	1-59½
	III. ·07,	——	1-78 51/100
	IV. ·06,	——	1-75 83/100
	V. ·04,	——	1-100½

It will be seen from this table, that the quantity of contraction is in a due relation to the diameter of the casting. No. IV. seems an exception, however, and appears to have shrunk more in proportion to its diameter than the other four. This may with safety be laid to the score of error in the moulding. In casting flat surfaces, the degree of contraction is in a just proportion to the length of the article.

	Inches.
A front pattern of polished tin measured exactly	24·5
When cast of soft gray iron, and cold, measured	24·250
Contraction	·25

Equal to 1-98th part the length of the pattern; the height of which, or rather breadth, was 20 inches; its thickness a quarter of an inch.

The contraction of two ash-grate patterns was ascertained as follows:

First pattern measured in length -	18·250 inches
When cast in soft iron - -	18·035
Contraction	·215

Equal to 1-84 88/100th part the length of the pattern.

Second

Second pattern measured in length	-	11·100 inches
When cast in soft iron	- -	10·975
	Contraction	·125

Equal to 1-$88\frac{88}{100}$th part the length of the pattern.

The breadth of No. I. was 11 inches, that of No. II. $8\frac{1}{2}$ inches: the thickness in both was ·475 inch.

I shall now finish this paper with some experiments made upon the casting of cannon shot. This operation is performed by pouring the liquid iron into a mould which is divided into two semi-spheres. The mould is possessed of a joint, which preserves the sphericity of the shot. It is formed by careful turning to gauges made with great care and exactness. This operation exhibits very distinctly the laws of shrinkage, contraction, and expansion; and from it I mean to prove the truth of what I only before assumed: 1st, That cast iron, when fluid, is then more dense than in any other state: 2d, That immediately upon its passing from the fluid to the solid state it acquires its greatest volume: and 3d, That when cold, and always in proportion to the absence of heat, so will be the diminished diameter of the shot.

To prove that cast iron is denser in the fluid state, several pieces of iron may be put into a ladle, and hot fluid iron poured upon them; they will immediately rise to the surface, and expose a considerable portion of their bulk above the surface of the liquid iron. This buoyancy diminishes; and as the pieces of metal approach more and more to the state of fusion that exists in the ladle, they gradually sink, till they disappear entirely under the surface; they then rapidly dissolve, and form a part of the fluid iron.

Melted cast iron supports also lead and tin in the same manner; but these soon become dissipated in the great heat of the fluid.

If a 6-pounder shot is placed in the bottom of a 12-pounder mould, or of any size larger, and hot melted metal poured in till the mould is filled, apparently a perfect shot is formed; but a few blows upon the upper part of the sphere, around the gate or runner, detect the surface of the small shot. The thickness of the iron here will not exceed 1-10th of an inch, while the bottom thickness will be nearly a full inch; and if the mould exceeds in diameter that of a 12-pounder, the inequality of thickness is greater. It is evident from this, that six pounds of fluid iron float six pounds of solid iron in the state of a sphere. That this property is permanent, may be further understood from a

continuation

continuation of the same experiment. If a short allowance of time is made after the mould is filled under the above circumstances, and this dexterously inverted, a fair inclosure will be found, possessing regular and equal thickness of new metal on all sides of the minor ball.

This is easily accounted for upon the same principle. When the mould was full, the ball, as usual, occupied its place near the runner. The iron first run into the mould, meeting with the greatest degree of cold, would immediately consolidate upon the bottom: when the mould was inverted, the ball would naturally tend to elevate itself to what was formerly the bottom of the mould; but its progress would be arrested by that portion of the iron now become a solid, and would remain stationary, more or less central in proportion to the fitness of the moment taken to perform the operation.

That cast iron occupies a greater bulk or volume immediately after it passes into the state of a solid, may be learned from observation as well as direct experiment. If a shot-mould is carefully separated at a certain period after filling, a metallic crust is formed, more or less thick, which is the natural progress of consolidation, but which is at present an envelope to a considerable portion of fluid contents. In this state the expansion, if any has taken place in the shot and mould, is nearly the same; the former is easily extracted from the under and upper parts of the latter. In about two minutes after, however, the expansion of the shot is more rapid than that of the mould; and at this period is difficult to disengage. As the heat is communicated to the mould, its dimensions enlarge, and the extraction of the shot is attended with less violent efforts. The mould is always filled by the shot till cooling has so far taken place as to reduce the shot-mould to its former diameter. Beyond this, however, the shot still continues to lessen its bulk, so that when cold it will be found to have left its mould by nearly 1-66th part of its diameter. In all cases where shot-moulds are re-filled before they have contracted, by cooling, to their original diameter, their product in shot will be various as to dimensions. The effects of this, particularly in summer, are inconceivable, and, though seldom adverted to, will account often for shot being rejected as unserviceable for not passing the gauge. This subject I at one time paid particular attention to, and, to ascertain the fact rigorously made the following experiments:

I selected seven pairs of shot-moulds, well seasoned, of the following sizes, 3, 4, 6, 9, 12, 34, and 32-pounders,

 These

These were cast or filled with the same quality of iron three times successively. The first interval of pouring was ten minutes, and the second fifteen minutes.

		Measured. Inches.	Weighed. Lbs.	Grs.
3-pounder shot,	1st Cast	2·724	2	6015
	2d ——	2·730	2	6031
	3d ——	2·736	2	6070
4-pounder shot,	1st ——	3·036	3	6125
	2d ——	3·054	3	6234
	3d ——	3·087	3	6289
6-pounder shot,	1st ——	3·240	5	4813
	2d ——	3·240	5	5031
	3d ——	3·290	5	5250
9-pounder shot,	1st ——	4·032	8	5906
	2d ——	4·050	8	6016
	3d ——	4·090	8	6236
12-pounder shot,	1st ——	4·440	11	5250
	2d ——	4·444	11	5480
	3d ——	4·512	11	5781
24-pounder shot,	1st ——	5·556	23	3830
	2d ——	5·574	23	4485
	3d ——	5·666	23	5690
32-pounder shot,	1st ——	6·114	31	5360
	2d ——	6·156	31	6343
	3d ——	6·268	32	1530

Upon this table I have only to remark, that the ratio of effect, both in the expansion and increase of weight, is exactly analogous to the weight or diameter of the ball, or, in other words, to the mass of fluid iron poured into the mould. When the last round of pouring was finished, the moulds possessed a temperature respectively to their sizes. The 32-pounder mould was thoroughly red-hot, though nearly two inches in thickness and weighing 140 pounds. In this and in the 24-pounder mould a curious species of adhesion had taken place in the bottom, betwixt the shot and the mould, by the moulders called burning. When the bullet is broken off, the mould exhibits an elevated spongy mass which resists the hardest-tempered steel.

About two years after the above experiments were made, I paid particular attention to the effects likely to be produced in a large way in the usual train of manufacture. My observations were conducted in a shop appropriated for shot-casting. The length of the house was 30 feet, breadth 16, side walls 8 feet, with a pavilion roof of the common range.

The work performed here was the filling of about 150 pairs

pairs of moulds, of all sizes, three times each day. These occupied the floor of brick in different ranges, and presented a very large aggregate of heated surface when poured. The quantity of metal thus formed into shot at each cast was nearly a ton. In May 1796 the average temperature of this workshop for several days during casting was 115° Fahr. One day a spirit-of-wine thermometer burst in my hand with a report like a pistol. Its greatest range of scale was 120°: the passages betwixt the moulds, for the movements of the pourers, were 130°. In all these extra temperatures I uniformly observed that a considerable portion of the shot, particularly in the third cast, passed the gauge with difficulty, and many of these found unserviceable for carronades, where the windage allowed upon the calibre of the piece is less. In the middle of August in the same year, during a period of very hot close weather, I made repeated trials, and found the effects always proportioned to the temperature of the workshop. I shall finish this paper with the particulars of one day's observations.

		Temp. of Room.
1st Cast, 9 in the morning - -		65°
in 5 minutes of casting rose	to	80
in 10	to	112
in 15	to	128
in 20	to	140
Greatest heat in 35 minutes, being three minutes after the pouring had ceased,		156

From 128 to 156° I felt a sensation of cold similar to that when approaching a fire in winter, accompanied by a considerable degree of shivering. About 150° this sensation wore off, and I felt comparatively comfortable. Perspiration had now become so violent as to ooze through all parts of my waistcoat, breeches, and stockings. The workmen who carried the metal perspired in such a manner as to wet their large sacking trowsers as if they had been soaked in water. The moisture ran in such torrents from their faces and arms, as to be distinctly heard hissing upon the heated moulds. Their step and arms were more agitated than I had ever before observed, and the sinews all over their bodies were uncommonly large, and felt inflated to a great degree. Two men performed the whole labour of pouring; so that each of them in 32 minutes carried half a ton of metal in quantities, in hand-ladles, from forty to fifty pounds each time. The space gone through each time, the return with the empty ladle included, was nearly 120 feet, or fully equal,

equal, upon the whole travel, to half an English mile; the half of which space was traversed with a ladle, metal included, weighing 80 pounds. One of the men, immediately after this operation, emptied a pitcher of spring water at one draught which I estimated at five English pints.

The phænomena of the 2d cast were not so marked. So much is the human body the child of habit, that I neither felt the same extent of sensation, nor remarked it upon the workmen, although the thermometer maintained itself for some minutes at 158°. In the afternoon the air began to circulate, and the temperature of the shop became much more moderate. The third cast, however, soon destroyed this pleasant change, and, before half done, the thermometer rose to 164°. Still the workmen seemed to suffer less than in the morning, except on the legs. Most of the ranges of large moulds were throwing off the caloric in ruelle undulations, and exhibiting symptoms of approaching redness. The smallness of the shop admitted only of 2½ feet of passage betwixt range and range; which made the temperature of this spot intolerable.

When the cast was finished I had the doors and windows shut. This made the real state of the moulds visible. The 18, 24, and 32-pounders were all of a dark glowing red heat, and presented an arid and inhospitable glare with which it was impossible long to exist.

II. *Of the Herring Fishery. Translated from the French of M.* DUHAMEL *and others.*

[Concluded from our last volume, p. 225.]

A general Idea of the Curing of Herrings.

THE French, Dutch, and English, cure herrings, some white and some red, and some like anchovies. But the French and Dutch cure but a small quantity of red herrings in comparison of the white ones: the English, on the contrary, redden the greatest part of the herrings taken in the Yarmouth fishery.

We have said already, that when the fishermen are near enough the coast so as to deliver in the day the herrings that they catch at night, they sell them fresh; but when this delivery cannot be made quickly, they corn them in the vessels; sometimes they throw them into casks together with salt in a confused manner, and sometimes pack them

them up in barrels. As these operations, which necessity sometimes requires to be done at sea, are executed better on land, we have reserved a more particular account of them for this place.

Of Half-salted or Corned Herrings.

When the fishermen cannot bring their herrings to land within twenty-four hours after they are caught, they give them a half salting: it is an important point that this should be done almost immediately after the herrings are taken out of the water.

This half salting is used likewise on land, when the herrings are to be cured either in the white or red way: when it is done at sea, it is as it were provisional, and serves to keep the fish for two or three days without spoiling. It is done in different manners. At sea, as it must be done expeditiously, they do not dress the herrings, that is, they do not take out the gills and entrails; which is very wrong, as undressed herrings are fit only to be reddened, or half reddened. As to the half salting itself, it is sometimes done in this manner: they put a small quantity of herrings in a tub, and pour some salt upon them with their hands: upon this layer of salt they place one of herrings, and then another of salt; after which they turn both herrings and salt up and down together. Another method of doing it is, to put a small quantity of herrings with some salt in a sort of copper pan, and then to mix and turn them about. These half salted herrings are sometimes thrown pell-mell into a cask, which is stopped up after a little salt has been put between the herrings: such herrings will keep for a long time, provided they have been dressed, and that there be salt enough put into the casks.

Sometimes the half salted herrings are made up in bulk, by laying them on some part of the vessel, after they have got the half salting, and adding a little more salt according as they are laid, and then covering the bulk with a sail to prevent the salt from falling off. This method is not near so good as the former, and herrings made up in this way are only fit to be half reddened. But casks are not to be had always at sea, and it often happens that the men have not time to dress the herrings or to half salt them in a proper manner.

On land, the half salting does not take place until the herrings have been first washed, dressed, &c.; and there are different methods of half salting.

In several ports they pour a certain measure of herrings into

into a large tub, and immediately strew upon them a thin layer of salt, which is repeated every time, according as other measures of herrings are put in, until the tub is full. They do not stir them, but let them take a proper proportion of salt before they pass to any other preparation.

In other ports, the women, after having dressed the herrings, put them in a trough, which is raised two feet above the ground, and is open at one end: this end is a little lower than the other, for the purpose of letting the fish slide out of the trough after they have been half salted. According as the herrings are put into the trough, the women strew some salt upon them, and turn them, until every part of them is equally covered with salt. They use about 150 lbs. of salt for every last, that is, from ten to twelve thousand herrings. When this operation is over, the herrings are drawn down into a basket, which is placed in a tub that receives the salt which falls from the herrings. They are afterwards casked, as shall be described in the sequel.

Of the Operation of Dressing preparatory to the making of White Herrings.

The herrings that are delivered fresh to the salters, as likewise those that have been half salted at sea, are treated in the same manner, unless the herrings of the second sort have been dressed already at sea: which would be of great advantage; for the herrings that are salted before they are dressed are much inferior to those that are first dressed and then salted; and in fact they never turn out well. There is an order of the parliament of Rouen prohibiting the mixing of them with the other sort: the fishermen, however, find means to sell them to those who make red herrings. According as the fresh herrings are brought to the salting-place, they are poured into large lavers full of water, some of which may contain several lasts of herrings. The women then set about dressing them: and first of all they take them, one by one, near the head in the left hand, and then press them between the fingers of the right, which they draw downwards from the head to the tail, so as to cleanse them and take off part of the scales; after which, raising up the cover of the gills, they take them out with the first fingers, and along with them the stomach and intestine, so that nothing remains in the body but the pey or milt. They usually make a light incision in the neck with a small knife; but care must be taken not to cut off the head, for herrings thus mutilated would be thrown among the refuse. According as herrings are prepared in

this manner, they are put into baskets, the milt herrings separately from the pey ones, to be carried over to the man that is to salt them. All the offals are thrown into the sea.

Of the Salter's Business.

To fresh herrings prepared as we have now described, the salters give a half salting, such as has been explained already. They then throw them, without order, into casks or large barrels, which they fill up without pressing the herrings, and let them sink by themselves for some hours; after which the coopers put on the heads of the casks. This is called casking, or salting in urak. The herrings are left in these casks for a fortnight or three weeks. This preparation is much the same as that which is used at sea. During that period the herrings sink and discharge their water, and there is formed a brine that covers them. Care must be taken not to let it flow off, for if the herrings were left dry they would be spoiled.

Of the Manner of Barrelling Herrings.

When it is supposed that the herrings have got salt enough, they are taken out of the casks, at sea or on land no matter, and barrelled. They are first poured out of the casks into a laver, in which the women wash them in their own brine. In the ports, where there is plenty of salt, some wash them in new brine; which method appears best, because the old brine, being mixed with the blood and lymph of the herrings, is more apt to be spoiled than the new brine. But if new brine be used, it should not be too strong. Be the brine what it will, the herrings must be well cleansed from whatever dirt they may have contracted. They are then taken out of the brine with perforated pallets or boards, and left to drip in wide baskets: when they have dripped sufficiently, the same women take them, one by one, and place them in the barrels, pressing them as close together as they can, and always placing the bellies uppermost. To press them the better (as it is of great consequence that they should be well pressed) the coopers use false bottoms, upon which they jump, and sometimes pressing machines. This precaution is particularly necessary in the barrelling of shotten herrings. It is also to be remarked, that such herrings as are parched, split in the belly, &c., are thrown among the refuse.

Salt is not generally used in the barrelling of herrings: however, if the barrels are made up to be sent by sea to hot climates, a small quantity of large salt is scattered between the beds of herrings.

In

In some ports they leave the barrels, after they have been headed, near one another, with the bung-holes uppermost, through which they pour in, at different times, some of the brine in which the herrings had been washed, after it has stood twenty-four hours in large casks to clarify by precipitation. The bungs are then closed, and the herrings are fit to be sold.

It is to be noticed that old brine clarified is preferred to new brine, and that some salters disapprove of the custom of pouring in brine by the bung-hole, for they say it makes the fish lose part of the brine which it had imbibed. But it does not appear how adding of new brine should make the herrings lose their own brine: it is probable that new brine is preferable to the old, which is mixed with the lymph and blood of the herrings. But as salt is very dear in several ports, it is the interest of the salters to be sparing of it.

Of Curing Herrings in Brittany.

After having dressed and half salted them, they make them up in barrels, with a layer of salt in the bottom, upon which they place a row of herrings, then another layer of salt, and so on alternately until the barrel is full, ending with a layer of salt. This quantity of salt forms a good deal of brine; and as in some time the herrings sink, they pour in new brine to fill up the barrels.

Salt is cheap in Brittany; and in fact, according to their method, much more salt is used than would be requisite. But perhaps their herrings would not keep otherwise; for their method is in reality the same as that in urak, viz. mere casking, which we have described already. It would be much better if experienced salters were employed, who would regularly go through the operations, of which an account has been given in the preceding paragraphs.

Of the Barrelling of Herrings in Holland.

As herrings are sometimes scarce near the coasts of Holland, the Dutch fish for them towards Shetland, to the north of Scotland, or at Yarmouth; and as such herrings cannot be brought fresh to Holland, the fishers salt them in casks, and bring them home in that state.

But whether the herrings be brought fresh or salted, the busses go up the canals, and the fish is delivered to the merchants.

Every merchant gets his herrings prepared before his house, the lower part of which is usually a store-room. If weather permits, the herrings are made up on the bank

of the canal; if not, this is done in the store-room, but always as soon as the fish has been delivered, whether fresh or salted. The herrings are poured into vats; the fresh ones are dressed, the bad ones are thrown aside: in short, the whole process is the same as that which is used in France, with this only difference, that in France women are employed in it, and in Holland men, who, being stronger, pack up the herrings more close together and more equally.

Their herrings should be salter than the French ones, because they throw a little white salt between every bed of herrings; but they use white salt, which, as we have said elsewhere, is thought to be weaker than that of Brouage: it is for this reason, and because the herrings of the North Sea are fat and oily, that some intelligent salters mix some Brouage salt with the white, which makes the flesh of those herrings firm. Some people find fault with the Dutch herrings for not being as free from liquor as the French ones: but let them say what they will, the Dutch herrings are of an excellent quality when half salted and casked immediately after they are taken; and there are none among them of two or three nights standing. The white Spanish and Portuguese salt they use makes their herrings appear to advantage: it is true, that such salt gives a certain sharpness to them, but they know how to correct it by adding some Brouage salt. In barrelling, they often make use of a pressing machine, and it is supposed that the brine which they add after the herrings are barrelled makes them look well, because they use new brine clarified by precipitation, and passed through a sieve.

Of some Defects particular to White Herrings.

Such herrings as have been too much cut in the neck, sides, or belly, in dressing, are considered defective.

Burnt or rusty herrings are those that are too much dried up by the salt, which happens either when new salt or too much salt has been used, or when the herrings are salted soon after spawning. On the contrary, they are soft and flabby when salt has been used too sparingly. This imperfection, if it has not gone too far, is remedied by putting some strong brine, or a small quantity of large salt, into the barrels, or, if there are but few of them, by making them up together with herrings that have been properly cured.

There are some shoals of herrings of a bad quality, either because they are near their spawning time, or because they

have been on bad bottoms. When salted they corrupt, and are called herrings of bad water.

Some herrings lose their water after being barrelled, and become yellow, fetid, and rusty.

The fishers and salters are of opinion that herrings do not keep well unless the milt and pey herrings are put in the same barrels; but picked herrings, all milts, have been cured that kept wonderfully well.

Of the Regulations for preventing Abuses in the Salting of Herrings.

At Dunkirk there is a police established both for the fishing for and curing of herrings, and every owner of a boat, before he goes out, presents himself to a magistrate and takes an oath that he will observe the regulations. Among other conditions, he promises not to salt any herrings but such as are caught in the twenty-four hours: and, to guard against frauds in the salting, there are inspectors appointed, who are to be present when the herrings are salted in the town, and fix a mark upon the barrels. Such herrings as could not be salted within the twenty-four hours are made into red herrings.

One of the greatest abuses is that of putting into the barrels some refuse herrings; and it is a still greater one to make white herrings of those of more than two nights taking. The herrings of one night being much better than those of two, it is proper to barrel them separately.

On this account the arrete of the parliament of Rouen, anno 1765, prohibits the bringing into port, or unloading as fresh, any other herrings but those of one, two, or three nights.

It orders, in art. 2, the masters of vessels going out on the fishery, and the salters on land, not to dress, salt, or barrel, any herrings but those of one or two nights. The herrings of three nights must be half-reddened (*bouffis*). When we say herrings of one night, we mean the herrings that were caught preceding the day of delivery.

The North sea and Yarmouth herrings, which are salted at sea, have usually the advantage of being salted in due time, before those that are brought fresh into port; and the picking out of large milt herrings diminishes the value of those that are made up for commercial purposes.

The council of state has issued several orders against the abuses. It has ordered,

1. That the herrings which are taken in the German Sea and

and in what is called the Yarmouth fishery, and which are casked at sea, be barrelled separately, in barrels marked with three flower-de-luces besides the merchant's mark.

2. That the Channel herrings of one night, and salted, be marked with two flower-de-luces; and those of two nights with one alone.

3. That out of eighteen barrels in cask there shall be formed only twelve made-up barrels, each of which must weigh at least 282lbs.

4. That the salting merchants do put their own marks upon the barrels; which is a very important point.

Of Red Herrings.

The English red herrings ought to be naturally the best of all, because they are made of Yarmouth herrings, and therefore of the best kind: besides that, they are of one night, because they are delivered on the coast immediately after being taken, and none of them are salted in the vessels. On the contrary, the red herrings that are cured in France are not Yarmouth herrings (of which the French make white ones), but are caught near the coasts of France, and they are of different nights. Yet, notwithstanding these and some other circumstances, the red herrings of the Channel sell more and look better than the English ones, which is attributed to their being smoked with very dry beech; but they cannot bear navigation, or heat, as well as the English herrings. The brown colour of these herrings, and their keeping better, may proceed from their being smoked and dried more than the French herrings; or it may be owing to their being fatter. This matter may receive some elucidation from the sequel.

As to the Dutch, when the herrings do not come to their coasts, as it happens in some years, they make white ones of all they take, both in the North and at Yarmouth; for they do not make red herrings but of such as are caught near their own coasts, and which have not been sold fresh.

Of the Utensils that are used in making Red Herrings.

There are large tubs like those which are used in the dressing of white herrings. There are also several sorts of baskets, some of which serve for the herrings to drip in, and some for other purposes, besides a quantity of switches sharp at one end, barrels, &c.

Of the Stoves, or Drying Places.

There are stoves of different dimensions. Some of them are in the lower part of the houses, others in the upper

 part.

part. Some of them are small separate houses covered with tiles, which are placed so as to let out the smoke. I shall describe one of the largest of them.—It is divided into three parts by two rows of a sort of ladders raised about six feet above the ground, and which reach up to the roof. As the herrings are about ten inches long, the laths, which form, as it were, the steps of the ladders, are placed at the distance of eleven inches from each other, so as to leave an inch between the tails of one row and the heads of another. On those laths, or steps, are placed the switches, or little wooden spits, from which the herrings are suspended. In each of those spaces or funnels in which the herrings are placed, there are two windows or vent-holes, which the director of the process opens, whenever he thinks proper, to prevent the herrings growing black. To this circumstance is probably owing the good colour of the French herrings. Underneath is a large hearth for the fire. The whole is closed up like a stove, but so as to admit a passage into it when necessary.

Of the Curing of Red Herings in France.

The species and quality of the herrings, whether red or white, are the same. The only difference is, that greater care is taken not to cure in the white manner but those of one or two nights, whereas red herrings are sometimes made of those of three nights, although they are not near as good for this purpose as the herrings of one night.

They are not dressed, that is, the gills are not taken out, nor are they gutted, but they are half-salted; for which purpose, when they are brought from the boat, they are put in a storehouse on a large table, or on the floor, which must be very even. Two men turn about a hundred of them at a time with wooden pallets, whilst another man throws salt upon them. In short, they are half salted in the same manner as the herrings that are to be cured in the white way; and this may be done in large tubs, or otherwise. The ordinance of 1650 allows for every last of herrings (between ten and twelve thousand) three minots (about three bushels) of salt. If they are intended for the provinces somewhat distant, they lie in the salt tubs for twenty-four or thirty hours; if for the Mediterranean, forty-eight hours; and for America, a little longer. After this they are washed with great care in fresh water. It is prohibited to wash them in the brine of white herrings, or in that which flows off after the half-salting: if such brines were used the herrings would turn infallibly in three or four days time. Some per-

sons think that weak brine made with new salt is preferable to water quite fresh, and they say that it makes the herrings look well.

They are washed in baskets, which are plunged several times into tubs of water. This is repeated until the salt is dissolved. According as they are washed and have dripped they are spitted, that is, strung by the head on the switches. Care must be taken not to let them touch one another, so that they may receive the warm air and the smoke in every part. According as the switches or spits are thus made up, they are handed to men who place them in the stoves, beginning from the top. The lowest row of switches is about six or seven feet above the hearth. When the rows are all made up they are left so for twenty-four hours, that the herrings may drip before the fire is kindled.

When the dripping is over they light the first fire, which is kept up day and night without intermission for fourteen or fifteen days, and inspected every two hours for the purpose of adding fuel to it, or of stirring it; for an equal degree of heat must be kept up. The fire is also now and then pushed from one part of the hearth to another. The management of the fire requires an experienced man, who can keep the fire always at the same degree of heat, and proportionable to the quality of the herrings. The fatter they are the longer the fire must continue: but still it must be a gentle fire; and it must cease when the herrings are fit for the next part of the process.

After the fire has been kept for a fortnight, or sometimes for twenty days, more or less, it is discontinued for three days to let the herrings discharge their oil, which is called the pissing of the herrings. When this is over, the fire is lighted again, and kept going with the same precautions as before for five, six, and sometimes seven or eight days. When the herrings are found to be perfectly dry, they are taken down and put on a table to be inspected, picked, &c.

We may observe that fifteen days in the drying place is sufficient for the herrings that are to be consumed in France; but those that are to be sent to the Mediterranean require twenty or five-and-twenty days, and sometimes more.

In the picking of them, such as are shotten, too much dried, &c. are set apart, and sold as refuse to the hucksters, &c. The rest are merchantable, and are barrelled.

The fire must be made of wood which produces great heat and smoke, and but little flame. In some ports they use oak, in some beech, and in others alder. They take care to keep the door of the drying-place constantly shut,

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and to warm the place gradually; for which reason they begin with lighting a fire in the middle of it: twenty-four hours after they light two other fires; and then two more, if the drying-place is large.

Care must be taken not to let the herrings get too warm; however, about the end of the process a smart fire is made to give them a perfect drying, and the entrance of the stove is closed with a large cloth.

Of the Preparation of Red Herrings in England.

The method of curing red herrings at Yarmouth is very nearly the same as that we have now described, But as the English make red herrings of almost all those they take, their establishments for this purpose are generally larger than ours. Some of their drying-places are fifty or sixty feet high, and may contain six or seven hundred thousand herrings; which causes a great œconomy of wood and of hands.

When the herrings have dripped, the fires are lighted much in the same manner as in France, and are continued for thirteen days, after which the herrings are left for three days in the piss. Then the fires are lighted again and kept for eight days, at the expiration of which they are left again in the piss for four days, and then they get the last fire, which lasts three days.

Thus their herrings remain in the drying-places for near five weeks, whereas in France this process lasts only about twenty-one or twenty-three days. It is true, that as the Yarmouth herrings are fatter than those of the Channel, they take more time to dry, and that if they were not dry enough they would corrupt, particularly if they were to be sent to remote and hot countries.

Some people find fault with the English herrings on account of their being of a darker colour than the French herrings; but this is not a real imperfection, as their colour is owing to their being fatter, on which account they must be kept longer in the stoves: some are of opinion, that when the English use beech in their stoves their herrings are less brown than when they burn oak; and we are not to imagine that they heat their stoves with pit coal. It is certain that the Yarmouth herrings are of a superior quality, and that they are cured very soon after being taken; which is a considerable advantage. But as there is no police to regulate the package of them, as there is in Holland and in several ports of France, bad herrings are often found in the Yarmouth barrels intermixed with the good ones.

Of some Imperfections peculiar to Red Herrings.

Such herrings as have stuck together when drying, lose their skin in the separating of them, and are therefore unmerchantable. Those that have got too much fire, or, what is worse, are burnt, are likewise set apart with the refuse.

Although it is allowed to cure herrings of three nights taking, yet it would be proper to put those of one, two, and three nights in separate barrels, as the herrings of one night are infinitely better than the others, and those of three nights are of a very inferior quality. As to the herrings of four nights, it is not allowed to sell them at all. There should be also a prohibition against salting with old brine, of any sort whatsoever, those herrings that are to be cured in this manner.

Of a Sort of Half-cured Herrings, called Bouffis (*swelled*), Craquelots, *or* Appetits.

These herrings do not keep long, and are usually made of shotten herrings, and of those of several nights, which are not fit to be cured in the white nor even in the red manner. As they are ready sooner than the red herrings, they find purchasers, and would be very delicate if they were made of good herrings, and attention paid to the curing of them. They are called *bouffis* (swelled), because the smart fire they are put to swells them.

It is not allowed to salt the herrings, that are to be cured as red herrings, in the brine of the white ones; but, on the contrary, it is usual to make use of this brine for salting the herrings we are now treating of. For they say that new salt would make them crack; which, indeed, is not probable. Be this as it may, this method of curing herrings is entirely left to the women.

According as the women receive the herrings they put them into large tubs, containing a quantity of brine, without pressing them against one another. Many of them are salted enough in the course of twenty-four hours: but the shotten herrings, as they discharge more blood than the full ones, are left in the brine for several days, and there is no danger of their taking too much salt. When they are taken out of the tubs they are filed upon switches or rods, and then hung up in small stoves that may contain five or six thousand herrings. It is not usual to let them drip; but as soon as the last rows are placed the fire is lighted. However, at first they put up only one-half of them, and keep the fire going for six hours; after which they put up

the other half, and a clear fire is continued for nine hours more. The stoves are heated with alder alone, dry pieces of which are used for the first fifteen hours; after which the herrings swell, as they had not discharged their water. After fifteen or sixteen hours the fire made of dry wood is stopped; and, for the purpose of giving the herrings a gold colour, the fire is then made of pieces of green wood, which are kept burning so as to emit a great deal of smoke and no flame. This fire is made merely to give the herrings a colour, for they have been dried already by the action of the smart fire. When the second fire has ceased the herrings are left to cool in the stove for about an hour, and are then taken down.

If there happens to be a great demand for herrings cured in this manner, they sometimes put fresh herrings that have got no salt at all in the stoves. They are very nice to the taste immediately after they are taken down, but do not keep; and accordingly this practice should not be allowed.

Herrings of one night, when prepared and properly cured in the manner already described, are very delicate; but, as they must swim in brine, a great quantity of it is requisite for a last of herrings.

Of Smoked Herrings, according to the Mecklenburgh Method.

It is said that as soon as the herrings are taken they are put in brine for a short time, and then filed upon rods, and hung up in a sort of tower, made of brick or wood, which is open at the top. A fire is made below of wood covered with moss, and, when a great quantity of smoke is produced, the top of the tower is covered with mats. The herrings are left there until they are supposed to be sufficiently dry, and then taken down and sold immediately. They say these herrings are excellent, but they do not keep long.

Of the Manner of Curing Herrings that are to be used as Baits.

About the end of the season, when the herrings are bad, the fishermen cure some of them for the purpose of baiting their hooks. Some fishermen salt them first in casks, that is, they give them a half-salting; but others cut off the heads and open them, from one end to the other, on the side of the belly, and take out the intestine, as likewise the milt and pey, if there be any. They also scrape the inside of the herrings with a knife; and when they have taken out the blood as much as possible, they throw them into a tub

tub full of fresh water, in which they wash them, rubbing them with their fingers, particularly near the long bone. From that tub they remove them into another containing clean water, in which they wash them again. When they are well washed, they are put into baskets and left to drip until the next day. About a hundred of them are then put into a basket, in which, while two women shake them, another scatters some salt upon them, until every part of them is salted; after which they are poured into a tub, in the bottom whereof is a layer of salt. When the tub is filled up to within about four inches of the brim, it is covered. The herrings will keep in this manner for baits, but are not fit to be eaten.

From the Transactions of the Highland Society of Scotland, Volume I.

In the curing of herrings it is a matter of the utmost consequence to attend to their condition during and after the first salting. If they be allowed to lie in the first pickle long, especially in barrels, exposed to the sun in hot weather, they are very apt to spoil, at least that portion of them which is nearest to the warm side of the barrels. Now a spoiled herring is not only itself incapable of being cured, but it spreads corruption to the others packed around it; and thus the evil spreads. If the weather be rainy, and the fish-barrels be left uncovered; or if the weather be warm; or if the herrings before salting have been long in a situation unfavourable for their keeping sound; or if they have acquired from any cause, as from the garbage not being well removed, &c. &c., a tendency to spoil; they ought to be examined carefully and repeatedly, should be soon changed, and, on being re-salted and packed, should have every unsound or suspected one thrown out. The time, therefore, which they may be allowed to lie in the first pickle, must depend entirely on circumstances. Perhaps the first pickling may be done in troughs, or large tubs, with more ease, expedition, cheapness, and safety, than in barrels in the common way. The Dutch, it is said, frequently use troughs for this purpose, filling them well up with fish, which touch and get the full effect of the pressure of the lids or covers. These are even made to press the fish more firmly by means of weights, screws, wedges, levers, or other mechanical powers.

III. *Sketch*

III. *Sketch of a Geological Delineation of South America.* *By* F. A. Von Humboldt.

[Continued from our last volume, p. 357.]

The cordillera of Parima never reaches to the same height as the Sierra Nevada in the province of Caraccas, which is 2350 toises. Their highest summit seems to be the Cerro de la Esmeralda, or the mountain Duida, which, by trigonometrical measurement, I found to be 1323 toises above the surface of the sea, which is the height also of the Canigou. This mountain is situated in a delightful plain covered with ananas and palms: the monstrous mass which it exhibits towards the Mission and the rivers Canu-canuma and Tamatama, and the flames it vomits up towards the end of the rainy season, give it a romantic and majestic appearance. No Indian is able to clamber up to the top of this mountain and the rocks of its summit without a week's labour, because the luxuriance of vegetation in this climate impedes the progress of travelling. Next to the Duida, the Maraguaca, more towards the east of the river Simirimoni, and the high cordillera of Cunarami and Calitamini, which at Maypuré and St. Barbara is known under the false name of Sipapo, are the highest summits of the chain; they are from 1000 to 1100 toises in height. The common height of the cordillera, however, does not exceed 600 toises, and sometimes it is less, as the part situated between the left bank of the Cassiguiaré, an arm of the Orinoco which connects together the Rio Negro and the river Amazon, and the sources of the cataracts and Piramena between Carichana and Morocote, is destroyed, and still exhibits insulated rocks rising from the ground. The cause of this destruction seems to have been an eruption of water from the bason of the Amazon river towards the bason of Calabozo and Baxo-orinoco, which differ in height about 160 toises.

The geological chart of this district which I have constructed represents an immense valley which unites the Llanos of the Rio Negro, Cassiguiaré, and Amazon, with those of the province of Caraccas, Barcelona, and Cumana; a valley which sinks down towards the north, and is intersected by a large series of single rocks which show the direction of the old cordillera on the banks of the Guaviare and Nuta in the province of Cassemora. The eastern extremity of this valley is the lowest part of it, and therefore the remains of the water of the Orinoco cut out for itself a

bed

bed in this place. This cordillera has two remarkable properties. In the first place, as has been remarked in other ridges, the southern declivity is much steeper than the northern: the high summits of Caravami, Jao, of the volcano of Duida, Maraguaca, &c., all lie towards the south, and are there cut into perpendicular precipices. In the second place, this cordillera does not seem to contain a single rock of alluvial mountains, and consequently has borrowed nothing from the organized kingdom. On our passage over this ridge we observed nothing but granite, gnieis, micaceous schist, and hornblend schist; nowhere a covering of sand-stone or alluvial chalk, which on the cordillera of Venezuela on the coast rises to the height of 976 toises above the level of the sea. Had the proximity of the equator and the rotation of the earth any influence on this phænomenon?

The third chain of original mountains, the cordillera of Chiquitos, is known only from the accounts of some persons who have resided at Buenos-Ayres and travelled through the Pampas. It unites the Andes of Peru and Chili with the ridges of Brasil and Paraguay as it stretches from La Paz, Potosi, and Tucuman, through the provinces of Maxos, Chiquitos, and Chaco, towards the government of the Mines and of St. Paul in Brasil. Their highest summits seem to be situated between the latitude of 15° and 20° south, as the streams between the rivers Amazon and La Plata divide themselves at that height.

Between the three cordilleras, the direction of which we have hitherto followed, lie three broad and deep valleys. 1st, The valley between the south side of the cordillera of Venezuela, on the coast, and the cordillera of the Cataracts, or the valley of Orinoco and Apuré, between latitude 8° and 10°. 2d, The valley of the rivers Negro and Amazon, bordered by the Parima ridge and the cordillera of Chiquitos, between latitude 3° north and 10° south. 3d, The valley of Pampas of Buenos-Ayres, which extends from Saint Cruz of Sierra to Cape Virgin, between 19° and 52° south latitude. The first and second valley are in some measure united by the destruction of a part of the Parima cordillera. I do not know whether this be the case also with the Pampas and valley of the Amazon; it, however, appears that it is not, though the Llanos of Monso form a sort of canal which descends from north-west to south-east. All these immense valleys or plains are entirely open towards the east, as they run out into a low sandy coast: towards the west they are shut by the chain of the high Andes. There are some creeks

(*anses*)

(*anses*) which proceed from east to west in the direction of the tropical current, and on that account extend further into the land the broader the continent is. The valleys of Apuré and Orinoco are closed by the ridge which extends from Pampelona to Merida in longitude 73°, and the valley of Pampas in longitude 70°: they both fall together a little towards the east, and seem to be covered by one and the same formation of alluvial strata.

Trailes says, that in Swisserland there is more reason to wonder at the depth of the lakes than at the height of the mountains: I will venture to make a similar observation in regard to the *Llanos* or plains of South America. How astonishing it is to see a continent which in its interior parts several hundred miles from the coast, and in the neighbourhood of mountains 3000 toises in height, is elevated scarcely fifty toises above the surface of the sea! If the flux in these places should rise to as great a height as at St. Malo and Bristol, and if more motion should be communicated to the ocean by earthquakes, the greater part of these valleys would be laid under water. The highest Llano which I have measured is that between the rivers Ymirida, Temi, Pimichia, Cassiguiaré, and Guiainia (Rio Negro); it is 180 toises in height; but it sinks down towards Atures in the north, as towards the river Amazon in the south. The valley of Orinoco and Apuré is still much lower than that of Cassiguiare and Calabozo in the middle of the Llano where I made observations, in latitude 8° 56′ 56″ and longitude 70° 9′ west from Paris. At Angostura, the capital of Guyana, latitude 8° 8′ 24″, longitude 66°, it is only 33 toises, and eighty miles from the coast scarcely eight toises above the level of the sea. The plains of Lombardy, in Europe, have the greatest resemblance to the Llanos on account of their small elevation. Pavia is only 34, and Cremona 24 toises in height; the other plains of Europe have a much greater elevation. In Saxony and Lower Silesia the plains are only from 87 to 120 toises in height; those of Bavaria and Swabia are from 230 to 250. The declivity of the Llanos of America is so gentle, their inequalities are so imperceptible, that no large river flows to either side. The Orinoco appears in the longitude of about 70°, as if about to discharge itself in the sea towards Portobello; but at Cabrouta it turns to the east without the least obstacle being discovered either there or at St. Fernando de Atabapo, in latitude 7° 55′ 8″, to oppose its course. In the large valley of Rio Negro, and of the Amazon river, is a tract of land, in 2° or 3° north latitude, of not less than

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1600 square miles, which is bordered by the large rivers Atabasso, Cassiguiaré, Guiainia, and Orinoco, and represents a parallelogram, in which the water flows on the four opposite sides in opposite directions. In regard to the Orinoco, I found a fall of 151 toises in the distance of 70 miles from the mouth of Guaviare to the Apuré; but from the capital to the sea not more than eight toises. La Condamine observed the same thing in regard to the river Amazon, from the narrow pass of Paucis to Para, where it runs through a district of 240 miles, but falls not more than 14 toises. It is not improbable that there might have been on the north side of the cordillera of the coast of Venezuela a plain as much lower than the plain of Orinoco as the plain of Rio Negro is higher than that of Orinoco, and on this account the former plain was covered by the water of the bay.

The two Llanos or plains which lie at the opposite extremities of America exhibit a striking difference from that which lies between them, namely, the vale of the river Amazon. The latter is covered by so impenetrable forests that rivers alone can force a passage through them, and that scarcely any other animals but such as frequent trees can live in that district; so much is vegetation favoured by the continual rains under the equator. The case is quite different with the plains of Orinoco and Pampas; they are level valleys covered with herbs, and savannahs which contain only a few scattered palm-trees. The same heat, the same want of water, and the same phænomena of refraction, that is to say, the inverted image of objects seen floating in the atmosphere, are observed here as in the deserts of Africa and Arabia. But plains so perfect are nowhere else to be found; for the Mesa de Pavone and the Mesa de Guanipa in 800 square miles contain no eminence of eight or ten inches in height. The plains of Lower Hungary, on the west of Presburgh, have the greatest resemblance to them; for the flat land of La Mancha, Champagne, Westphalia, Brandenburgh, and Poland, is hilly when compared with the Llanos of South America. Nothing but a long stagnation of water could have produced so horizontal a bottom. Traces of old cities are found here, but seldom are any seen which rise like castles (La Piedra Guanan, longitude 69° 3′, latitude 1° 59′ 48″) in the Llano of Cassiguiaré and of Rio Negro. But from St. Borja to the mouth of the Black river Condamine observed no eminence; and the Llano of Orinoco is also without islands. As the Morros of San Juan belong to the southern declivity of the cordillera of Venezuola,

zuola, an impetuous current of water must have swept every thing along with it; and the present sea presents large spaces without islands: instead of islands there are in the Llanos whole uninterrupted portions of from 200 to 300 square miles of surface which rise from two to five feet above the plain, and which are called *mesas* or *bancos*; which is as much as to say, that they were shoals or sand-banks in the antient sea. I must here observe, that the middle of the plain of Orinoco is the most beautiful and levellest part of it. The bottom of this immense bason rises up and becomes unequal at the edge; the plains therefore which one traverses between Guyana and Barcelona are less perfect and level than those of Calabozo and Uritucu.

This remarkable difference which we found between the cordillera of Venezuola and that of the Cataracts, which is that the latter consist of alluvial mountains entirely bare, is observed between the northern Llano of the Orinoco and that of the Rio Negro and river Amazon. In the former, the original mountains are every where covered with compact limestone, gypsum, and sandstone: in the latter the granite every where appears. The more one approaches the equator the thinner is the stratum of sand which covers the crust of earth on the original mountains: in a land where vegetation is so luxuriant, there is seen in the middle of forests spaces of 40,000 square toises scarcely covered with a few lichens, and which do not rise two inches above the rest of the surface. Will the same be discovered in Africa? for it is only in America and Africa that there is land under the equator.

Having taken a view of the direction of the mountains and valleys, or the form of the inequalities of the earth, let us now turn our attention to objects of more importance which have been less examined, namely, the rising and falling of the strata of the original mountains which form this part of the earth I have traversed. I have been convinced since 1792 that the rising of the original mountains follows a general law, and that, making allowance for those inequalities which may have been produced by trifling local causes, and particularly veins and strata in mines, or by very old valleys, the stratified coarse-grained granite, the foliated granite, and particularly the micaceous schist and argillaceous schist, rise in the league 3½ by the miner's compass, as they form with the meridian of the place an angle of 52½°. The falling of the strata is towards the northwest; that is to say, they fall parallel with a body that might be thrown in the same direction, or the aperture of the

the angle of inclination (less than 90°) which it makes with the earth's axis stands towards the north-east. The rising is more constant than the falling, especially in the simple mountains (argillaceous schist, hornblend schist), or in the compound mountains with fewer crystallized grains, such as the micaceous schist. In granite (it is, however, found very regularly stratified rising in the league 3 — 4, and falling towards the north on the Schneekopfe, the Ochsenkopfe, the Siebengebirge, and the Pyrenees,) and in the gnieis the attraction of the crystallized mixed parts to each other seems to have prevented the regular stratification; therefore more coincidence is found among the micaceous and argillaceous schist, and these first led me to the idea of the law of rising during my tour to the Fichtelberg and the Thuringian forest. Since that time I have examined with great care the angle of the strata of other original mountains in other parts of Germany, in Swisserland, Italy, the southern parts of France, and the Pyrenees, and lately in Gallicia. Mr. Freiesleben, whose labours have been of so much service to geology, assisted me in this examination; and we were astonished at the uniformity in the rising and falling of the mountains which we found at each step on one of the highest cordilleras of the earth, the Alps of Savoy, the Valais, and the Milanese.

An examination of this phænomenon, and of the identity of the strata, was one of the principal objects when I undertook a voyage to America. A measurement of the angles which I have hitherto made on the cordillera of Venezuola and Parima gave again the result of my observations in Europe in the chain of the micaceous schist mountains of Cavaralleda as far as Rio Mamon; on the Silla de Caracas at the height of 1000 toises; of the Rincon del Diablo, on mount Guigue; in the islands in the beautiful lake of Valencia, which has almost the same elevation as the lake of Geneva, at the boundaries of the isthmus of Maniguaré and Chupariparu; on the hornblend schist which appears uncovered in the streets of the capital of Guyana, and also in the Cataracts, and on the stratified granite at the foot of the Duida. Every where the strata form an angle of 50° with the meridian (in the league 3 — 4 by the Saxon compass) as they rise from the north-east to south-west, and fall about from 60 to 80 towards the north-west.

This great coincidence in the old and new world must excite serious considerations. It exhibits a very important geological fact. After so many observations which I have made in places so far distant from each other, it can no

longer be believed that the rising of the strata follows the direction of the cordillera, and that the falling follows the declivity of the mountains. The profile of many of the mountains, particularly a section of the mountains, such as that of Genoa through the Bochetta, and of St. Gothard as far as Franconia in Germany, which I intend to publish at a proper time, proves exactly the contrary. The rising and declivity of the cordillera, the form of the small inequalities of the earth, seem to be newer phænomena. A stream might scoop out a valley in this or in that direction; might tear asunder a part of the cordillera, and give it apparently one direction or another. The strata of the original mountains appear, amidst all these angles of rising and falling observed at present, to have existed before these changes at the surface of the earth. They are the same at the summit of the Alps, and in the mines into which we descend. When one travels for 15 miles over strata of argillaceous schist, which are inclined parallel to each other, at an angle of 70° towards the north-west, one can no longer believe that they are deranged strata, which once stood horizontal. We must suppose mountains that were once 15 miles in height, and that the whole mass had an uniform fall, and then reflect on the space which such a mass would occupy: and one must remember the strata on the heights of Genoa, or on the heights of Bochetta, or on St. Maurice, which are exactly parallel; and on the strata of the Fichtelberg of Gallicia, the Silla de Caracas of Robolo on the isthmus of Arava of Cassiguiare, in the neighbourhood of the equator. One must allow that this coincidence gives evidence of a cause which has acted at a very early period, and in a general manner; a cause which must have arisen from the first attraction by which matter was forced together to form a spherical planet.

This grand cause does not exclude local causes, by which individual smaller parts of matter were determined to arrange themselves in this or in that manner, according to the laws of crystallization. Delametherie has made an ingenious remark on this subject: he shows the influence of a large mountain (as a small nucleus) on the neighbouring small mountains. One must not forget that, besides the general attraction towards the centre, all matters exercise a mutual attraction on each other.

The crust of the earth, for I will venture to speak only of this part, must be the result of an immense action of powers of attraction of affinities, which determined, put in equilibrium, and modified each other. M. Klugel

thought

thought he found, by calculation, that the great flattening of the earth must be on the west side of the north pole. Has the axis of rotation been changed? What will be the inclination of the strata in the southern hemisphere? We are not acquainted with the cause; let us rather continue to examine the phænomena.

This falling of the strata of the original mountains in the cordillera of Venezuola has a great and melancholy influence on the fertility of the provinces of Caracas, Cumana, and Barcelona; the water which filtres through at the summit of the mountain flows down according to the direction of the strata, and for this reason there is great want of water in the whole large district which lies on the south side of the cordillera, and therefore so many springs and small streams burst forth on the northern declivity, which, by this great quantity of moisture, and the superabundance of wood, which shelters it almost the whole day from the sun's rays, is rendered as unhealthful as it is fruitful.

The alluvial mountains which I have hitherto observed are almost under the same circumstances as in Europe. The oldest seem to have experienced the action of the same causes which determined the strata of the original mountains, as they rise in the league 3—4, or as the seamen express it, N. 50 E. They often fall towards the south-east, as in the Alps of Bern, the Valais, Tyrol, and Steyermark; but the greater part of them, and particularly the newest, which where I have been are the most numerous, follow no certain law; their strata often lie horizontally, or rise towards the edge of the large dried-up basons, which in America are called Llanos, and in Africa Deserts.

La Condamine says that in Peru and Quito he observed no petrifactions. The cordillera of Quito, however, is not like that of Parima, naked granite, for at Cuença, and on the south side, there is gypsum and alluvial chalk. Buffon dwells much, in his *Epoques de la Nature*, on the question whether South America contains petrifactions? I have found an immense quantity of them in calcareous alluvial sandstone which covers the northern and southern declivity of the coast of Venezuola, from the summit of St. Bernandin, and the Altos de Conoma, to the Cerro de Meapiré, or the headland of Puria and Trinidad. The same stratum is found also in Tobago, Guadaloupe, and St. Domingo. An immense quantity of sea and land shells, which in Europe are seldom found mixed together, cellulariæ, madrepores, corallines, and astroites, are found in-

terspersed in this sandstone. The shells themselves are half broken: whole rocks consist merely of such remains reduced to powder. My fellow-traveller, Bonpland, discovered in them shells of the genus Pinna, Venus, and Ostrea, of which living specimens are still met with on that coast; an observation of great importance to geology. Every thing shows that this stratum, which I have seen only at the distance of nine or ten miles from the present coast, is of very modern origin, and that the fluid in which it was produced had been in a state of violent motion. The petrified shells in a much older stratum of compact limestone are scarcer and much differently stratified: they are anomia, terebratulites, &c. placed together in families, and in such a manner that it is seen that they have lived (as those of Mount Salive, the Heinberg near Göttingen, of Jena, and Geneva) on the spot where they are now found petrified. They are not interspersed throughout the whole mass of the limestone; they are only peculiar to certain strata. Many rocks may be examined without finding any of these petrifactions; but where found they are in great quantity, and present themselves chiefly on great heights; peculiarities which they have in common with the shells found in the limestone of the high Alps of Swisserland and Salzburg, which is identic with the hardened marl of Thuringia, a limestone which lies above the very old sandstone.

I must observe also, that, besides the new sandstone stratum with a calcareous base, of which I have already spoken, the petrifactions do not often occur; and I was particularly astonished to find no single belemnites or ammonites which are so common in all the mountains of Europe. The Llano of Orinoco, and that even of Rio Negro, are covered with a coarse grained breccia (*nagelfluhe)* which contains no petrified shells, and perhaps covers the other alluvial strata with petrifactions. But this breccia contains on the other hand petrified trunks of trees, which are sometimes found of the length of a toise, and of the diameter of two feet. They seem to belong to a kind of Malphigia.

The sandstone which contains all kinds of marine animals (the quarry of Punta del Barrigon near Araya is of this sort) never exceeds the height of from 30 to 40 toises. In several places it forms the bottom of the Gulph of Mexico (Cabo Blanco, Punta Araya). In the compact limestone I never saw petrified shells above the height of 800 toises; but other very new testimonies prove the residence of the water at much greater heights. Slate found on the Silla de

 Caracas,

Caracas, at the height of 1130 toises, proves that the water once, as on the Bonhomme in Savoy, formed this aperture between the two peaks or pyramids of the Avila, an aperture which is much older than the five counted in the cordillera of the coast, namely, those of Rio Neveri, Unare, Tuy, Mamon, and Guyaca. Among the mountains of the province of Cumana, there are very singular valleys of a perfect circular form, which seem to be dried up lakes. Of this kind are the valleys of Cumanacoa and St. Augustine, 507 toises in depth, which are celebrated for the refreshing coolness which travellers experience in them.

When the modern action of water is considered, two opposite effects are observed: one recollects a very distant epoch, when the irruption of the sea formed the Gulph of Cariaco and the Golfo Triste; separated Trinidad and Margaretha from the main land, and convulsed the coast of Mochima and Santa Fé, where the islands of la Boracha, Picua, and Caracas, form a heap of ruins. The sea then attacked the land; but the contest did not long continue: the ocean again begins to draw back. The islands Coche and Cuagua are shoals which emerged from the water; the large plain of Salado, lying in Cumana, belongs to the Bay of Cariaco, and is only 5½ toises above the level of the sea. The hill on which the castle of St. Antonio is situated was an island in this gulph, as an arm of the sea passed to the north of Tatoraqual through the Charas towards Punta Delegada, as is proved by a multitude of unaltered shells. It is observed here and at Barcelona that the sea is daily retiring: in the harbour of Barcelona it has lost in 20 years above 900 toises. Is this decrease of the sea in the Gulph of Mexico general, or is it the case here, as in the Mediterranean Sea, that it gains in one point and loses in another? This retreat of the sea must not be confounded with another real phænomenon easy to be explained, namely, the decrease of fresh water, of rain, and of the rivers in this continent. The Orinoco, as we see it at present, is no longer the shadow of what it was 1000 years ago, according to the evidence of the traces which the water has left on both banks at the height of 70 or 80 toises. These traces have long attracted the notice of learned Europeans who have seen the Barraguan, the Cueva de Atarnipe (the burying place of the Atures Indians, who formed a kind of mummies), the Cerro Cuma, the Daminari, the Keri, Oco, and Ouivitari, the bottom of which at present is scarcely covered by the foam of the Cataracts of Maypuré. These traces remind the Indians of a great inundation, during

 which

which many persons saved themselves on rafts of Agave, and afterwards cut out inscriptions and hieroglyphics, with which the granite of Urmana, of Incaramada, and the banks of Cassiquiaré, are seen covered, but of which no one at present has the key. This tradition, common among the Indians of Erovato and of Parima, shows great analogy with the mythology of the antients. People think they read the history of Deucalion, and Pauw would find the remembrance of this flood not uninteresting.

[To be concluded in our next.]

IV. *Natural History and Anatomical Description of a new Genus of Fish named Polyptera, found in the Nile. By* G. Geoffroy*.

It is in general among fish with fixed branchiæ and a cartilaginous skeleton that the most varied and most curious forms are found: it is there that the important modifications of some of the organs which constitute life necessarily determine the major differences in the rest of the organization. But among the abdominal fishes, where these beings have so great relation to each other, there is one species almost entirely different from those analagous to it, and, as we may say, foreign in the midst of its family. This no doubt is a new object of consideration for natural history, and worthy the attention of physiologists.

This species, known in Egypt under the name of *bichir*, is indeed so anomalous in regard to abdominal fishes, that it may be said to have no other relation to them than in the respective position of the pectoral and ventral fins; and that in other respects it is entirely different.

I. *Physiognomy of the Bichir*. The appearance of this fish might cause it to be considered as a serpent, and on this account, indeed, it has been distinguished among the Egyptians by the name of *bichir* or *aboubchir*: its head is defended by broad osseous pieces, and its body is clothed with large scales. It is in some measure cased in armour. It is particularly remarkable by the extent of its abdomen, the length of which is equal to four-sixths of its whole body.

II. *Organs of Motion*.—The *bichir* seems to be deprived of that organ which acts the principal part in natation; for its tail is exceedingly short, being equal at most to no more than

* From *Annales du Muséum National d'Histoire Naturelle*, No. 1.

than a twelfth part of its whole length: but there is nothing real in this inconveniency. The fins of this fish, which correspond to the extremities of the mammalia, are formed in such a manner that it can employ them at pleasure, like the phocæ, either for natation, or walking, or for reptation. We are already acquainted with a similar organization, that of the Lophia, the pectoral and ventral fins of which are placed at the end of carneous prolongations; but this genus belongs to the order of jugular fishes, where the extremities are found in an inverted order, and cannot serve for attaching these animals to any body but under certain circumstances.

The *bichir* then in this respect exhibits a more complete analogy to quadrupeds. To appreciate its just value we shall here give a description of the pectoral and ventral fins.

The anterior extremity, which is 2 inches 7 lines, is longer than the posterior, and the arm is very little shorter than the fin, being 1 inch 10 lines: it is very flat, naked internally, and covered with scales only on the exterior side: it contains all the bones which compose the anterior extremity of quadrupeds.

The omoplata is a large square piece at the top of which is an apophysis, broad at the base, which articulates with the back part of the plates of the head: the sternum is of an elongated form, disposed transversely, and remarkable for a large groove situated before: below is the clavicular bone which projects outwards in such a manner as to accompany the humerus, and to serve like it for the articulation of the fore arm. In regard to the humerus, it is a very short small bone, of less breadth than the clavicle, with which it is accompanied: all these small bones are separated only in young individuals: in adults they are united in such a manner as to form one bone, where the traces of their former separation are always indicated by sutures.

The fore arm is composed of two long, slender, and unequal bones, the cubitus and the radius, which separate at an angle of 50°. A very thin round osseous plate, which I consider as a real carpus, occupies the centre of this separation, and on the semicircular base of this triangle the apophyses which defend the radii rest: this kind of metacarpus is terminated by fins.

Among the muscles with which the fore arm is provided, we distinguish an adductor, and particularly large flexors and extensors, which line the interior and exterior part of the metacarpus.

The posterior extremity is far from presenting so many points of resemblance with that of the mammalia. The limb (4 lines) is exceedingly short in regard to the fin (1 inch 5 lines); besides, it is composed of only five bones. The first, which, with its fellow, performs the office of a pelvis, is long and flat, and terminates in a broad base, at the extremity of which are articulated four small elongated and parallel bones. The protecting apophyses of the radii, though extremely short, envelop, however, on each side, the extremity of these small bones; which is possible, because each radius composed of two laminæ is terminated by a double apophysis.

This organization is seen on a more extensive scale and more distinctly in the anal fin; where each radius, composed of two triangular laminæ, united only by their anterior edge, is disposed in such a manner that the first radius receives the second, the second the third, the third the fourth, and so on.

The dorsal exhibits a fact of organization no less curious than what has been described. It is composed of sixteen, seventeen, or eighteen osseous radii, eleven lines in length, separated from each other, compressed transversely, of equal breadth, that is to say three lines, and terminating in two sharp points. These osseous laminæ, by rising up along the whole back, present in case of need a formidable armour. That these laminæ, however, may have a base proportional to their solidity, they are articulated directly with the upright apophyses of the vertebræ, and not, as in the other fishes, with the protecting apophyses of the radii; for this purpose the upright apophyses of the vertebræ are stronger, and terminated by a head destined for the articulations of the radii. The protecting apophyses, by this singular arrangement, become useless; they however exist, but are smaller, and inserted under the skin in the cellular tissue: they are merely the rudiments having a little more development.

The dorsal radii are not only transformed into a double-pointed dart; but each of them also is a particular fin; for there arises from the posterior surface of the laminæ a transparent membrane, which far exceeds the radius itself (or 1 inch 6 lines), which is supported towards the upper part by four small round cartilaginous radii, having each a particular origin. This series of small fins is prolonged without interruption as far as the caudal fin, so that they are distinguished only by the difference of their radii.

The tail is very shor , compressed on the sides, and terminates

minates in a point: the fin which borders it below and above is however rounded at its extremity: the radii are subdivided in proportion as they recede from their origin; those of the pectoral and ventral fins have a resemblance to them, except in the difference of their height. They are all so close to each other that they do not seem to be susceptible of motion.

III. *Of the Head.*—The branchial aperture is of considerable size, which is never the case in other fishes, unless the number of the branchio-stege radii increase in proportion. But in the *Lichir* there are none: they would indeed be almost useless, since the branchio-stege membrane, instead of being so thin as to fold up or expand at pleasure, consists of a thick skin. As it is of sufficient extent to exceed a good deal the opposite edge of the branchial aperture, it is supported towards the middle by a long osseous plate.

It may readily be imagined that a branchio-stege membrane, like the present, cannot perform the functions which it is known to perform in other fishes, if the arrangement of the plates which cover the head did not compensate for this deficiency by a supplementary organization, which brings all these parts into perfect agreement.

The middle of the head is protected by a large plate, composed of six pieces all articulated together. This kind of helmet is separated from the operculum by a band composed of small square pieces, which coming from the eye proceed obliquely on the nape of the neck. About the middle it is observed that two of these pieces adhere by a membrane only to the first piece of the operculum, while their opposite edge is free. As this fissure communicates with the cavity of the mouth, the water conveyed into the branchiæ is strongly compressed both by the pieces of the operculum, and by the long plate which supplies the place of the branchio-stege radii: this liquid raises up the two small moveable pieces, and opens a passage through which it escapes as through a valve.

The operculum exhibits nothing remarkable: it is composed of three pieces; the anterior and posterior are nearly of the same size; the third, which is situated between the two, is much smaller, and has the form of an equilateral triangle: above this third piece the two others are contiguous. The leaves of the branchiæ are single.

The form of the head approaches near to that of the *esoces*: it is long and flat from the top downwards, and the inferior jaw projects a little forwards.

The mouth is large, and furnished with a double row of equal, fine, and sharp teeth, placed very near to each other. The cavity of it is filled by a tongue exceedingly thick, free, and not covered with teeth, as in the *esoces*. On the sides of the mouth there are two prolonged lips, the upper one of which only is supported by a cartilage. This cartilage is nothing else than a thick tendon: a little above, towards the place where the moveable lip begins, there is found a small barbillon two lines in length, and between the two barbillons two small holes which are the apertures of the nostrils.

The eye is situated behind and on the sides of the head; it is flattened, and deeply lodged in the cavity.

IV. *Of the general Teguments.*—The *bichir* is cased in armour nearly in the same manner as the esox-cayman: its scales are large, thick, rhomboidal, strongly fixed in the skin, and distributed obliquely in bands: each of these bands begins at the middle line of the back and ends at the middle line of the belly, in such a manner as to form with the band of the opposite side an angle of nearly 45 degrees.

The general colour of the *bichir* is a sea-green; the belly inclines a little to a dirty white: this colour is set off by some black irregular spots, more numerous towards the tail than the head. The lateral line is straight, and not very visible. The general size of the *bichir* is one foot six inches in length.

V. *Organs of Digestion.*—The *bichir* in this respect approaches more to the *rays* than the *esoces*, with which one might at first be tempted to class it. At the extremity of a very spacious œsophagus, one inch two lines in length, is found the stomach, four inches five lines in length and one inch two lines in breadth: it is cylindric in a part of its length, and conical at the extremity. The intestine, which originates at the upper part of the stomach, first rises, and then folding itself back proceeds straight to the anus: a little below the arch which it forms there is found a very short cœcum five lines in length, wanting in most of the *esoces*, which proceeds towards the head. In the inside of the intestinal canal there is observed, as in the squali and rays, a membrane fixed to the intestine by one of its edges and rolled up in such a manner as to form by its different folds so many cells, which stop the course of the aliments and make them remain in the intestine the time necessary for digestion. Though this wonderful mechanism, which makes up for the shortness of the intestines, is already known,

known, it is still astonishing to meet with it in a fish of the order of the abdominals.

VI. *Of the other Abdominal Viscera*; *and* 1st, *of the Air Bladders.*—The genus of the *esox*, like most abdominal fishes, has only one air bladder adhering to the sides, and occupying the whole extent and length of the abdominal region. In the *bichir* there are two of these air bladders: they are two unequal cylinders which adhere only to the stomach and the liver. The smaller, eleven lines in extent, accompanies the stomach and terminates in a point: the larger, which is seven inches four lines, occupies the whole length of the abdomen. Towards the upper and lower part of the œsophagus is a fissure which opens into these bladders. This large aperture is shut, when necessary, by one constrictor muscle.—2d, *The Liver*. In the *esox* it is one large and entire mass; in the *bichir* it is formed nearly like the air bladders, being composed of two slender and unequal lobes: the small portion proceeds on the right side of the stomach; the longer, which is also slenderer, on the left of the intestinal canal. The gall bladder arises from the long portion: it has the form of a long-necked bottle; it is one inch four lines in length, and four lines in diameter. 3d, *The Spleen* is a ribbon-like body, of the consistence of the liver, and adheres to the large air bladder.—4th, *The Kidneys* have nearly the same form: they are two in number, and lodged on each side of the projection of the vertebral column; in this they are very different from one kidney of a pulpy consistence, such as that observed in the *esox*.—5th, *The Ovaria*, which are eleven inches in length, present nothing remarkable: they are attached to the neighbouring organs only by a cellular tissue so loose that they form themselves into a ball, or become elongated, according to the manner in which the fish is carried. The eggs are not larger than a grain of millet. They are of a meadow-green colour, while the whole of the ovarium appears of a blackish brown.

VII. *Habits of the Bichir.*—Notwithstanding all the care I employed to obtain information respecting the manners of this fish, I was not able to succeed. It is so rarely found in the Nile, that several fishermen informed me they had never seen any other individuals than those which I showed them. The high price which I gave for each *bichir* is a sure proof that all those which appeared in the general market at Cairo were brought to me; and yet I purchased no more than three or four in the course of a year. It was caught at the time when the waters of the Nile were lowest, and I never was able to obtain any young individuals.

duals. Having found that all the fish of the Nile are divided by travellers into two classes: that some during the decrease of the river ascend from its mouth, and that others descend from Nubia at the time of the inundation, I was desirous of knowing to which of these divisions the *bichir* belonged: but I never met with any person who could inform me. All that I was able to gather from the information I obtained was, that the *bichir* frequents only the deepest parts of the river; it lives constantly in the mud; and that, abandoning its retreats only in the spawning season, it is then sometimes caught in the fishermen's nets. I have not learned on what it feeds. I opened and dissected three individuals, but their stomachs were entirely empty. By the extent of its mouth, however, the numerous teeth with which it is armed, and the conformation of the intestinal canal, there is reason to believe that it is carnivorous. Its flesh is white, and much more savoury than that of the other inhabitants of the Nile. As it is proof against the attacks of a knife, it must be boiled: the skin is then more easily detached, and may be removed in one piece.

VIII. *Natural Relations.*—The genus to which the *bichir* approaches most is that of the *esoces*: it has even some resemblance to the cayman and scaly eel; a resemblance for which it is indebted to its integuments, and the distribution and size of its scales. But it may be readily conceived that this is not a consideration of sufficient importance to induce us to class it among the *esoces*, since it differs from them, as well as from the other known abdominal fishes, by organs much more essential. It is the only one of this order which has its fins placed at the extremity of the arm, the only one in which the place of the branchio-stege radii is supplied by an osseous plate; the only one which has a kind of air-holes furnished with valves to shut these apertures outwardly: all characters by which it approaches the cetacea: it is also the only one in which the dorsal line is furnished throughout its whole length with small fins; in which the first radius of these fins is transformed into a dart with two points; in which the apophyses of the vertebræ support immediately the osseous radii of the dorsal fins; which has a tail so short that it is almost useless for natation; and which, in regard to the organs of digestion, seems to establish a shade between the abdominal and cartilaginous fishes. From these considerations I think myself authorized to determine, that as the *bichir* cannot be admitted into any of the known divisions, it ought to be considered as an insulated being, and in that state of anomaly which naturalists usually

usually denote by the name of a new genus. I shall therefore establish the genus as follows:

POLYPTERA.

Charac. One branchio-stege radius; two spiracles; a great number of dorsal fins.

POLYPTERA BICHIR.

Inhabits the Nile.

Explanation of the Plate.

Fig. 1. (Plate I.) Polyptera.

Fig. 2. the head seen from above, AB, aperture of the spiracles.

Fig. 3. insulated dorsal fin seen on one side, in which may be observed the two points that terminate the osseous radius.

V. *Account of the Process followed by M.* PIERRE JAQUES PAPILLON *for Dyeing Turkey Red.*

IT is now some years since M. Papillon established a dye-house at Glasgow for giving to cotton-yarn that beautiful red colour known by the name of Turkey or Adrianople red. In the year 1790 the commissioners and trustees for manufactures in Scotland paid a premium to M. Papillon for communicating to the late Dr. Black, then professor of chemistry, Edinburgh, a description of his process, on condition that it should not be divulged for a certain term of years, during which M. Papillon was to have the sole use of his own secret. The term being now expired, the process, as communicated to Dr. Black, has been published, and is as follows:

Receipt for Dyeing Cotton-Yarn a durable Red.

Step I.

For one hundred pound of cotton, you must have

100 lb. of alicante barilla.
20 lb. of pearl-ashes.
100 lb. of quicklime.

The barilla is mixed with soft water in a deep tub which has a small hole near the bottom of it, stopped at first with a peg. This hole was covered in the inside with a cloth, supported by two bricks, that the ashes may be prevented from running out at it, or stopping it up while the ley filters through it.

Under

Under this tub is another to receive the ley, and pure water is repeatedly passed through the first tub to form leys of different strength, which are kept separate at first until their strength is examined. The strongest required for use must swim or float an egg, and is called the ley of six degrees of the French hydrometer, or *perseliqueur*. The weaker are afterwards brought to this strength by passing them through fresh barilla; but a certain quantity of the weak, which is of two degrees of the above hydrometer, is reserved for dissolving the oil, the gum, and the salt, which are used in subsequent parts of the process. This ley of two degrees is called the weak barilla liquor; the other is called the strong.

Dissolve the pearl-ashes in ten pails, of four gallons each, of soft water, and the lime in fourteen pails.

Let all the liquors stand till they become quite clear, and then mix ten pails of each.

Boil the cotton in the mixture five hours, then wash it in running water and dry it.

Step II.—*Bainbie, or Gray Steep.*

Take a sufficient quantity (ten pails) of the strong barilla water in a tub, and dissolve or dilute in it two pailsfull of sheep's dung; then pour into it two quart-bottles of oil of vitriol, and one pound of gum arabic, and one pound of sal-ammoniac, both previously dissolved in a sufficient quantity of weak barilla water; and, lastly, twenty-five pounds of olive oil which has been previously dissolved or well mixed with two pails of the weak barilla water.

The materials of this steep being well mixed, tramp or tread down the cotton into it until it is well soaked: let it steep twenty-four hours, then ring it hard and dry it.

Steep it again twenty-four hours, and again wring and dry it.

Steep it a third time twenty-four hours, after which wring and dry it; and, lastly, wash it well and dry it.

Step III.—*The White Steep.*

This part of the process is precisely the same with the last in every particular, except that the sheep's dung is omitted in the composition of the steep.

Step IV.—*Gall Steep.*

Boil twenty-five pounds of galls, bruised in ten pails of river water, until four or five are boiled away; strain the liquor into a tub, and pour cold water on the galls in the strainer to wash out of them all their tincture.

As

As soon as the liquor is become milk-warm, dip your cotton hank by hank, handling it carefully all the time, and and let it steep twenty-four hours.

Then ring it carefully and equally, and dry it well without washing.

Step V.—*First Alum Steep.*

Dissolve twenty-five pounds of Roman alum in fourteen pails of warm water, without making it boil; skim the liquor well, and add two pails of strong barilla water, and then let it cool until it be luke-warm.

Dip your cotton, and handle it hank by hank, and let it steep twenty-four hours; wring it equally, and dry it well without washing.

Step VI.—*Second Alum Steep.*

Is performed in every particular like the last; but after the cotton is dry steep it six hours in the river, and then wash and dry it.

Step VII.—*Dyeing Steep.*

The cotton is dyed by about ten pounds at once, for which take about two gallons and a half of ox blood, and mix it in the copper with twenty-eight pails of milk-warm water, and stir it well; then add twenty-five pounds of madder, and stir all well together. Then, having beforehand put the ten pounds of cotton on sticks, dip it into the liquor, and move and turn it constantly one hour, during which gradually increase the heat until the liquor begins to boil at the end of the hour. Then sink the cotton and boil it gently one hour longer, and lastly wash it and dry it.

Take out so much of the boiling liquor that what remains may produce a milk-warm heat with the fresh water with which the copper is again filled up, and then proceed to make up a dyeing liquor, as above, for the next ten pounds of cotton.

Step VIII.—*The Fixing Steep.*

Mix equal parts of the gray-steep liquor and of the white-steep liquor, taking five or six pails of each.—Tread down the cotton into this mixture, and let it steep six hours; then wring it moderately and equally, and dry it without washing.

Step IX.—*Brighton Steep.*

10lb. of white soap must be dissolved most carefully and completely in sixteen or eighteen pails of warm water: if any little bits of the soap remain undissolved they will make

spots in the cotton. Add four pails of strong barilla water, and stir it well. Sink the cotton in this liquor, keeping it down with cross sticks, and cover it up; boil it gently two hours, then wash it and dry it, and it is finished.

Vessels.

The number of vessels necessary for this business is greater in proportion to the extent of the manufactory; but in the smallest work it is necessary to have four coppers, of a round form.

1st, The largest, for boiling and for finishing, is twenty-eight inches deep, by thirty-eight or thirty-nine wide in the mouth and eighteen inches wider in the widest part.

2d, The second for dyeing is twenty-eight deep, by thirty-two or thirty-four in the mouth.

3d, The third, for the alum steep, is like the second.

4th, The fourth, for boiling the galls, is twenty deep by twenty-eight wide.

A number of tubs, or larger wooden vessels, are necessary, which must all be of fir, and hooped with wood or with copper.

Iron must not be employed in their construction, not even a nail; but where nails are necessary, they must be of copper.

By the pail is always understood a wooden vessel which holds four English gallons, and is hooped with copper.

In some parts of the above process, the strength of the barilla liquor or liquors is determined by telling to what degree a *perseliqueur* or hydrometer sinks in them.

The *perseliqueur* was of French construction. It is similar to the glass hydrometer used by the spirit dealers in this country; and any artist who makes these instruments will find no difficulty in constructing one with a scale similar to that employed by M. Papillon, when he is informed of the following circumstances:

1st, The instrument, when plunged in good soft water, such as Edinburgh pipe water, at temperature 60° sinks to the 0, or beginning of the scale, which stands near the top of the stem.

2d, When it is immersed in a saturated solution of common salt, at the same temperature of 60°, it sinks to the 26° of the scale only; and this falls at some distance from the top of the ball.

This saturated solution is made by boiling, in pure water, refined sea or common salt, till no more is dissolved, and by filtering the liquor when cold through blotting paper.

It

It should also be observed, that whenever directions are given to dry yarn to prepare it for a succeeding operation, that this drying should be performed with particular care, and more perfectly than our driest weather is in general able to effect. It is done therefore in a room heated by a stove to a great degree.

VI. *The Life of* John Dollond, *F. R. S., Inventor of the Achromatic Telescope**.

In modern times the attention of men has been employed rather in improving what they know than in attempting to make new discoveries. When a man, therefore, has been fortunate enough, by extraordinary research, or by a strong effort of genius, to surprize the world with a new invention. a lively interest is immediately excited in every mind to trace the steps, investigate the means, and collect every incident which led to the result: and to the honour of human nature be it said, while curiosity exerts itself in this manner on the invention, the inventor is not less the object of regard and consideration; we wish to learn the history, the life, the character of the man, and, as far as it is possible, to be acquainted with him. The subject of the following memoir is entitled to this introduction, and the public will receive with satisfaction the following account of the inventor of the achromatic telescope:

John Dollond, fellow of the Royal Society, was born in Spitalfields, on the tenth day of June in the year 1706: his parents were French protestants, and at the time of the revocation of the edict of Nantz, which happened in the year 1685, resided in Normandy; but in what particular part of it is not, at present, precisely known: M. de Lalande does not believe the name to be of French origin: but however this may be, the family were compelled soon after this period to seek refuge in England in order to avoid persecution and to preserve their religion.

The fate of this family was not a solitary case; fifty thousand persons pursued the same measures, and we may date from this period the rise of several arts and manufactures which have become highly beneficial to this country. An establishment was given to these refugees, by the wise policy

* Communicated by J. Kelly, D. D., rector of Copford and vicar of Ardleigh, Essex.

of

of our government, in Spitalfields, and particular encouragement granted to the silk manufactory.

The first years of Mr. Dollond's life were employed at the loom; but, being of a very studious and philosophic turn of mind, his leisure hours were engaged in mathematical pursuits; and though by the death of his father, which happened in his infancy, his education gave way to the necessities of his family, yet at the age of fifteen, before he had an opportunity of seeing works of science or elementary treatises, he amused himself by constructing sun-dials, drawing geometrical schemes, and solving problems.

An early marriage and an increasing family afforded him little opportunity of pursuing his favourite studies: but such are the powers of the human mind when called into action, that difficulties, which appear to the casual observer insurmountable, yield and retire before perseverance and genius: even under the pressure of a close application to business for the support of his family, he found time, by abridging the hours of his rest, to extend his mathematical knowledge, and made a considerable proficiency in optics and astronomy, to which he now principally devoted his attention, having in the earlier stages of his life prepared himself for the higher parts of those subjects by a perfect knowledge of algebra and geometry.

Soon after this, without abating from the ardour of his other literary pursuits, or relaxing from the labours of his profession, he began to study anatomy, and likewise to read divinity; and finding the knowledge of Latin and Greek indispensably necessary towards attaining those ends, he applied himself diligently, and was soon able to translate the Greek Testament into Latin; and as he admired the power and the wisdom of the Creator in the mechanism of the human frame, so he adored his goodness displayed in his revealed word.

It might from hence be concluded that his sabbath was devoted to retired reading and philosophical objects; but he was not content with private devotion, as he was always an advocate for social worship, and with his family regularly attended the public service of the French protestant church, and occasionally heard Benson and Lardner, whom he respected as men and admired as preachers. In his appearance he was grave, and the strong lines of his face were marked with deep thought and reflection; but in his intercourse with his family and friends, he was cheerful and affectionate; and his language and sentiments are distinctly recollected

recollected as always making a strong impression on the minds of those with whom he conversed. His memory was extraordinarily retentive, and, amidst the variety of his reading, he could recollect and quote the most important passages of every book which he had at any time perused.

He designed his eldest son, Peter Dollond, for the same business with himself; and for several years they carried on their manufacture together in Spitalfields; but the employment neither suited the expectations nor dispositions of the son, who, having received much information upon mathematical and philosophical subjects from the instruction of his father, and observing the great value which was set upon his father's knowledge in the theory of optics by professional men, determined to apply that knowledge to the benefit of himself and his family; and accordingly, under the directions of his father, commenced optician. Success, though under the most unfavourable circumstances, attended every effort; and in the year 1752 John Dollond, embracing the opportunity of pursuing a profession congenial with his mind, and without neglecting the rules of prudence towards his family, joined his son, and in consequence of his theoretical knowledge, soon became a proficient in the practical parts of optics.

His first attention was directed to improve the combination of the eye-glasses of refracting telescopes; and having succeeded in his system of four eye-glasses, he proceeded one step further, and produced telescopes furnished with five eye-glasses, which considerably surpassed the former; and of which he gave a particular account in a paper presented to the Royal Society, and which was read on the 1st of March 1753, and printed in the Phil. Trans. vol. xlviii. page 103.

Soon after this he made a very useful improvement in Mr. Savery's micrometer: for instead of employing two entire object-glasses, as Mr. Savery and M. Bouguer had done, he used only one glass cut into two equal parts, one of them sliding or moving laterally by the other. This was considered to be a great improvement, as the micrometer could now be applied to the reflecting telescope with much advantage, and which Mr. James Short immediately did. An account of the same was given to the Royal Society, in a paper which was afterwards printed in the Phil. Trans. vol. xlviii. page 178 *.

* This kind of micrometer was afterwards applied by Mr. P. Dollond to the achromatic telescope.

Mr. Dollond's celebrity in optics became now universal; and the friendship and protection of the most eminent men of science flattered and encouraged his pursuits. To enumerate the persons, both at home and abroad, who distinguished him by their correspondence or cultivated his acquaintance, however honourable to his memory, would only be an empty praise. We cannot, however, forbear mentioning the names of a few persons, who held the highest place in his esteem as men of worth and learning: Mr. Thomas Simpson, master of the Royal Academy at Woolwich; Mr. Harris, assay-master at the Tower, who was at that time engaged in writing and publishing his Treatise on Optics; the Rev. Dr. Bradley, then astronomer royal; the Rev. William Ludlow, of St. John's college, Cambridge; Mr. John Canton, a most ingenious man, and celebrated not less for his knowledge in natural philosophy, than for his neat and accurate manner of making philosophical experiments. To this catalogue of the philosophical names of those days, we must add that of the present astronomer royal, the Rev. Dr. Maskelyne, whose labours have so eminently benefited the science of astronomy.

Surrounded by these enlightened men, in a state of mind prepared for the severest investigation of philosophic truths, and in circumstances favourable to liberal inquiry, Mr. Dollond engaged in the discussion of a subject, which at that time not only interested this country, but all Europe. Sir Isaac Newton had declared, in his Treatise on Optics, page 112, "That all refracting substances diverged the prismatic colours in a constant proportion to their mean refraction;" and drew this conclusion, "that refraction could not be produced without colour;" and, consequently, "*that no improvement could be expected in the refracting telescope.*" No one doubted the accuracy with which Sir Isaac Newton had made the experiment; yet some men, particularly M. Euler and others, were of opinion that the conclusion which Newton had drawn from it went too far, and maintained that in very small angles refraction might be obtained without colour. Mr. Dollond was not of that opinion, but defended Newton's doctrine with much learning and ingenuity, as may be seen by a reference to the letters which passed between Euler and Dollond upon that occasion, and which were published in the Phil. Trans. vol. xlviii. page 287. and contended that, "If the result of the experiment had been as described by Sir Isaac Newton, there could not be refraction without colour."

A mind constituted like Mr. Dollond's could not remain

main satisfied with arguing in this manner from an experiment made by another, but determined to try it himself: and, accordingly, in the year 1757, began the examination; and, to use his own words, with "a resolute perseverance," continued during that year, and a great part of the next, to bestow his whole mind on the subject, until in the month of June 1758 he found, after a complete course of experiments, the result to be very different from that which he expected, and from that which Sir Isaac Newton had related. He discovered "*the difference in the dispersion of the colours of light, when the mean rays are equally refracted by different mediums.*" The discovery was complete, and he immediately drew from it this practical conclusion, "That the object-glasses of refracting telescopes were capable of being made without being affected by the different refrangibility of the rays of light." His account of this experiment, and of others connected with it, was given to the Royal Society, and printed in their Transactions, vol. l. page 743. and he was presented in the same year, by that learned body, with Sir Godfrey Copley's medal, as a reward of his merit, and a memorial of the discovery, though not at that time a member of the society.

This discovery no way affected the points in dispute between Euler and Dollond, respecting the doctrine advanced by Sir Isaac Newton. A new principle was in a manner found out, which had no part in their former reasonings, and it was reserved for the accuracy of Dollond to have the honour of making a discovery which had eluded the observation of the immortal Newton*.

This new principle being now established, he was soon able to construct object-glasses, in which the different refrangibility of the rays of light was corrected, and the name of achromatic given to them by the late Dr. Bevis, on account of their being free from the prismatic colours. Dr. Hutton, in his Mathematical Dictionary, has said that this name was given to them by M. de Lalande; but that is a mistake.

As usually happens on such occasions, no sooner was the achromatic telescope made public, than the rivalship of

* The cause of this difference of the results of the 8th experiment of the 2nd part of the first book of Newton's Optics, as related by himself, and as it was found when tried by Dollond in the years 1757 and 1758, is fully and ingeniously accounted for by Mr. Peter Dollond in a paper read at the Royal Society on the 21st of May, 1789, and afterwards published for J. Johnson in St. Paul's Church Yard; also in Hutton's Dictionary—Article, Chromatic.

foreigners, and the jealousy of philosophers at home, led them to doubt of its reality; and Euler himself, in his paper read before the Academy of Sciences at Berlin, in the year 1764, says—" I am not ashamed frankly to avow, that the first accounts, which were published of it, appeared so suspicious, and even so contrary to the best established principles, that I could not prevail upon myself to give credit to them;" and he adds, " I should never have submitted to the proofs which Mr. Dollond produced to support this strange phænomenon, if M. Clairaut, who must at first have been equally surprized at it, had not most positively assured me, that Dollond's experiments were but too well founded." And when the fact could no longer be disputed, they endeavoured to find a prior inventor, to whom it might be ascribed, and several conjecturers were honoured with the title of discoverers.

Mr. Dollond's improvement in refracting telescopes was of the greatest advantage in astronomy, as they have been applied to fixt instruments; by which the motions of the heavenly bodies are determined to a much greater exactness than by the means of the old telescopes. Navigation has also been much benefited by applying achromatic telescopes to the " Hadley's sextant:" and from the improved state of the lunar tables, and of that instrument, the longitude at sea may now be determined by good observers to a great degree of accuracy; and their universal adoption by the navy and army, as well as by the public in general, is the best proof of the great utility of the discovery.

In the beginning of the year 1761, Mr. Dollond was elected fellow of the Royal Society, and appointed optician to his majesty, but did not live to enjoy those honours long; for on the 30th of November, in the same year, as he was reading a new publication by M. Clairaut, on the theory of the moon, and on which he had been intently engaged for several hours, he was seized with apoplexy, which rendered him immediately speechless, and occasioned his death in a few hours afterwards. Besides Mr. Peter Dollond, whom we have had occasion to mention in the course of this memoir, his family, at his death, consisted of three daughters and a son, who, possessing the name of his father, and we may add, a portion of the family abilities, carries on the optical business in partnership with his elder brother.

VII. *Memoir by Lord* NAPIER, *of Merchiston, the celebrated Inventor of the Logarithms, on his different Contrivances "for the Defence of this Island;" with Remarks.*

SIR, *To Mr. Tilloch.*

THE following memoir has been already published in Dr. Anderson's excellent miscellany, THE BEE, vol. iii. p. 133. but your readers will perhaps agree with me in thinking it deserves republication, and may not be displeased to find it accompanied with some observations, which I believe have not before been brought together. The original of this very curious paper is preserved among the manuscripts of Anthony Bacon, Esq. in the Lambeth Library, marked 658, anno 1596.

Yours, &c. * D.

" Secret inventions, profitable and necessary in these days for the defence of this island, and withstanding of strangers, enemies to God's truth and religion.

" *First*, The invention, proof, and perfect demonstration, geometrical and algebraical, of a burning mirror, which receiving of dispersed beams of the sun, doth reflex the same beams altogether united, and concurring precisely in one mathematical point, in the which point, most necessarily it engendereth fire; with an evident demonstration of their error who affirm this to be made a parabolic section. The use of this invention serveth for the burning of the enemy's ships at whatsoever appointed distance.

" *Secondly*, The invention and sure demonstration of another mirror, which receiving the dispersed beams of any material fire, or flame, yieldeth also the former effect, and serveth for the like use.

" *Thirdly*, The invention and visible demonstration of a piece of artillery, which shot, passeth not lineally through the army, destroying only those that stand in the random thereof, but superficially ranging abroad, within the whole appointed place, and not departing forth of the place, till it hath executed his whole strength, by destroying all those that be within the bounds of the said place. The use hereof not only serveth greatly against the army of the enemy on land, but also by sea, serving to destroy and cut down, at one explosion, the whole masts and tackling of so many ships as be within the appointed bounds, as well abreid as in large, so long as any strength at all remaineth.

 " *Fourthly*,

" *Fourthly*, The invention of a round chariot in metal, made of the proof of double musquet, whose motion shall be such, that those that be within the same shall be more easy, more light, more speedy, and more safe in battle, than any hitherto contrived. The use hereof in moving, is to break the array of the enemy's battle, and to make passage, as also in staying and abiding within the enemy's battle. It serveth to destroy the environed enemy, by continual charges and shot of the arquebuss, through small holes; the enemy in the mean time, being amazed, and altogether uncertain what defence or pursuit to use against a moving mouth of metal.

" These inventions, besides devices of sailing under the water, with divers other devices and stratagems for harming of the enemies, by the grace of God, and work of expert craftsmen, I hope to perform.

JOHN NAPIER, of Merchiston,
Anno Domini 1596, June 2.

Remarks on the above.

I. The accension of combustible bodies by the solar rays concentrated in the focus of a concave mirror, was well known to the antients, it being the 31st, and concluding proposition, of the Treatise on Catoptricks, generally ascribed to Euclid*; and it was by such mirrors, according to Plutarch, in the life of Numa, that the vestal fires were rekindled. There can be no doubt that the Magi, who were equally scrupulous about their sacred fire, renovated it by the same means. The antients also knew, that if a number of plane mirrors were so disposed as that each of them should reflect the image of the sun to the same spot, a combustible substance placed there would be set on fire. It was precisely in this way, according to the Grecian poet Tzetzes, that Archimedes, at the distance of a bow-shot, projected the rays of the sun on the fleet of Marcellus, before Syracuse, and re-

* Dr. Rutherford, in his Syst. of Nat. Philos. vol. i. p. 448. says, that the author of this piece on Catoptrics, who, we may be certain, was not Euclid the geometrician, has erroneously supposed the burning point, or focus of the sun's rays, in a concave mirror, to be in the centre of the sphere, whereof it is a portion. And Wolfius, in his *Elem. Mathes. Univer.* t. iii. p. 187. charges not Euclid only, but all the antients with this error. But how then, it may be asked, could they be acquainted, as they certainly were, with the *actual use* of such mirrors? Herigon, in the Catoptrics, which he gives as Euclid's, without mentioning the error of his author, places the focus where it ought to be, namely very nearly, or, as to sense, exactly, in the middle of the axis, between the centre and the concave reflecting surface.

duced

duced it to ashes. Proclus is recorded by Zonaras to have destroyed the ships of Vitalian, besieging Byzantium (now Constantinople), by a similar apparatus. The same facts are mentioned by other antient historians; but their hints respecting the apparatus itself are too imperfect to afford any explicit knowledge of its structure. But, as appears from other passages of his life*, a very obscure hint was sufficient to set in action the genius of Napier; and the foregoing memoir gives us every reason to believe that, putting a happy construction on the words of Tzetzes, this second Archimedes was the first among the moderns who recovered this admirable invention of his illustrious precursor. So completely had it been buried in the wreck of antient science, that Descartes, who certainly understood at least the *theory* of optics better than any man of his age, when he published his Dioptrics, above forty years after the date of Napier's memoir, mentions the burning of bodies, at any considerable distance, by means of mirrors, as an almost hopeless project, and scarcely refrains from treating the famous exploit of Archimedes as a fable †. Descartes was a great man, and *therefore* his scepticism was, as usual, adopted by the common herd, the *servum pecus*, of philosophers, and even by some men of real learning and ability. Of this last description was M. Ozanam, who says plainly that the catoptrical achievement of Archimedes is *incredible*; and indeed not without reason, if the distance really was (as he states it, upon what authority does not appear,) 375 geometrical paces, equal to 1875 French feet, or 2002 English ‡. This, it must be confessed, seems to be giving too *poetical* an interpretation to the bow-shot of the poet Tzetzes. The justly celebrated Christian Wolfe seems also disposed to give little credit to this curious piece of history; though he quotes father Kircher as having concluded, from an actual survey of the site of the town and harbour of antient Syracuse, that the distance to which Archimedes had to project the solar rays could not exceed *thirty* paces §. This distance is probably nearer the truth: at least it is more agreeable to our modern ideas and experi-

* See the story of Dr. Craig in lord Buchan's elegant Life of Napier, and in Dr. Hutton's excellent Mathem. and Philos. Diction. art. *Napier*.

† *Cartesii Dioptrice* (first printed in 1637), cap. viii. sect. 22.

‡ See M. Ozanam's *Recreations Math. et Phys*, tom. i. p. 144, ed. 3. Perhaps Dr. Hutton's late much improved translation of this curious work may afford the reader more satisfaction on this point.

§ *Elementa Matheseos Universæ*, tom. iii. p. 188.

ments, as well as to the accounts which have been transmitted to us of the prodigious havoc which the engines of Archimedes, some of which could not possibly act at any great distance, made among the ships of the enemy *. Be this as it may, the incredulity of so many modern philosophers, some of them deservedly esteemed on other accounts, naturally tended to discourage any attempts to verify the performances ascribed to Archimedes and Proclus. The surprizing effects of the concave reflectors of Tschirnhausen, Vilette, Sir Isaac Newton and others, fall not under our present consideration, as having been produced only at small distances. At length, in 1726, M. du Fay found that, "at 200, 300, and even as far as 600 French feet" (about 640 English), "the rays of the sun received on a plane mirror, one foot square, and thence reflected to a concave one 17 inches" (above 18 English inches) "in diameter, consumed combustible bodies in the focus of the latter †." This interesting and literally *brilliant* experiment no doubt had its influence in stimulating the active

* See the antient authors quoted by bishop Wilkins in his Mathematical Magic, book i. chap. 17; and by Dr. Hutton, in his Dictionary, art. *Archimedes*.

† V. Mem. de l'Acad. Roy. des Sc. An. 1726. Father Regnault appears to have strangely misunderstood this experiment of M. du Fay. "*Encore quelque pas*," &c. "A few paces more," (so that he, as well as Ozanam, seems still to have thought the distance at which Archimedes burned the ships to have been greater than Kircher had given grounds to believe it really was,) "A few paces more," says Regnault, "and the secret of Archimedes is discovered or verified:" *Phys.* tom. iii. *Entretien* 10. The same author, in his *Origine anc. de la Phys. nouv.* (printed 1735), tom. ii. p. 283, has these words, "*On raconte que les mirroirs*, &c. It is said that the mirrors of Proclus and Archimedes burned the fleets of their enemies. With a plane glass and a concave mirror we now know how to excite flame at 600 feet distance." Here would not the reader be apt to conclude that the flame was excited, not in the *focus* of the concave, between the two mirrors, which were 600 feet asunder, but at that distance from the concave itself? Certainly the secret of Archimedes was far from being discovered by M. du Fay, who produced his effect by a double reflection; whereas circumstances must have confined Archimedes to a single reflection; unless we can believe that Marcellus would allow him to fix his concave to the ship he intended to burn, and to bring some of the ropes, &c. into its focus. Saverien, in his *Diction. de Math. et de Phys.*, article *Mirroir*, quotes Regnault's *Physique*, and appears to have inadvertently followed his loose description, and even to have made it still more ambiguous. M. du Fay's own account of his experiment, inserted in the text, is quite plain and explicit Perhaps Regnault's works are not much read; but Saverein's Dictionary (printed in 1753) is pretty generally referred to. It is a work of merit and utility, and therefore its errors being the more likely to mislead careless readers, should not pass uncorrected by those who observe them.

mind

mind of Buffon to attempt the production of fire by one reflection only. But, as he himself intimates, he was chiefly prompted to make this trial by a passage in the third part of the *Magia Catoptrica* of Kircher *, who says, *Ego certe hujus rei,* &c. "I certainly made trial of this matter with five plane specula. The heat, at the first reflection, was different from that of direct light. The light when doubled gave a very perceptible increase of heat; when tripled, it had the heat of a fire; when quadrupled, the heat could still be endured; but a five-fold light made the heat almost intolerable." Hence he concludes that a numerous combination of plane mirrors, which should reflect the sun's light to the same point, would produce much greater effects than any parabolic, hyperbolic, or elliptic burning mirror. This, he says, he is warranted to affirm, from experiments he made with his five plane specula, at the distance of 100 feet and upwards. And he earnestly entreats mathematicians to pursue this object with their utmost diligence. Kircher was born in 1601 †, five years after the date of Napier's memoir. It is generally said that his experiments were suggested by the hints of Tzetzes; and, no doubt, would be encouraged by his finding, on "diligent examination" of the spot in 1636, that "the combustion said to have been kindled by Archimedes was possible, and that the caustic line was but about 30 paces," or about 160 English feet. Thus the count de Buffon had only to put in execution the directions of Kircher ‡, which he did, in March and April 1747, with great perseverance, ingenuity, and expense. After various trials, with combinations of different numbers of plane mirrors, the greatest consisting of 400, placed in a square frame and brought to bear upon the object by means of screws, he succeeded in melting lead and tin at the distance of about 50 English yards; and in burning lighter substances, at the distance of 75 yards. With summer heat, and a better apparatus, he expresses a certainty of producing combustion even so far as 400 French feet, equal to 142 of our yards, and perhaps further §. This, if Kircher's admeasurement was right, may be reckoned at least double the distance at which Archimedes produced his conflagration; and thus he and Buffon together have at last

* Quoted by Paulian in his valuable *Diction. de Physique*, article *Catoptrique.*

† See Hutton's Dictionary, article *Kircher.*

‡ Paulian's Dictionary, article *Castel.*

§ See the *Mem. de l'Acad des Sciences*, an 1747; *Diction. de Phys. de Paulian*, art. *Catoptrique*; and Hutton's Dictionary, art. *Burning Glass.*

convinced

convinced most learned men that the renowned antient really performed the great exploit recorded of him. "The discovery," says the excellent Mauperitus, "of the mirror of Archimedes, which has been made by M. de Buffon, shows us that we might construct burning towers or amphitheatres covered with mirrors, which would produce a fire whose violence would have no other limits, so to speak, than those of the sun itself*." Fortune, leisure, and genius, are necessary to the success of all such experiments. Lord Napier possessed these indispensable requisites as well as the count de Buffon; and when we consider what has been actually done by the French philosopher, and invented in far more arduous departments of science by the Scottish one, we have no right to doubt that he could actually have verified the first proposal of his memoir. His expression "at *any* appointed distance," can only mean such a distance as might be reasonably prescribed in a case of this kind.

II. Our illustrious author's *second* proposal has the appearance of far greater difficulty than the first, and, as far as I know, can derive little or no support from the collateral evidence of other experiments antient or modern. Paulian, in the article already cited, speaks, in general terms, of kindling agaric, and gunpowder, by the rays of burning charcoal, collected by one concave and reflected from another; adding, that the experiment succeeds best in the dark. Wolfius is more explicit. On the authority of a philosopher of the name of Zahn, he tells us that this experiment was performed at Vienna, "*ope duorum speculorum*, &c., by means of two concaves of brass. The largest was six feet, and the least three," (whether in diameter or focal distance does not appear,) "and they were set 20 and 24 feet asunder. In the focus of the largest were placed pieces of burning charcoal, and in that of the least a candle, whose wick was wrapt round with a thread dipt in sulphur. The result was, that the reflected rays from the coals lighted the candle †." (The ingenious members of the Askesian Society have very lately fired gunpowder by a similar apparatus.) And Regnault, in the place before quoted, affirms, that "the moderns have spherical concaves which kindle gunpowder with the rays of charcoal, in the *foci* of each other, at the distance of 50 French feet,"

* See *Lett. sur le Progres des Sciences*, in *Les Œuv. de Maupertuis*, p. 349.

† *Elem. Mathes. Univ.* tom. iii. p. 191.

above

above 53 English.) But what is all this to the purpose? These results were procured by two reflections; and Napier, in burning an enemy's fleet, could only use one reflection, if indeed, in this instance, he did not also have recourse to refraction. Of such an effect not a trace is to be found in any of the books to which I have access. But I will not be so rash as to affirm the thing to be impossible in itself, or even beyond the ability of Napier. We have seen how much the greatest philosophers were mistaken about the practicability of his first proposal, afterwards so happily verified by Kircher and Buffon.

III. On our illustrious author's *third* proposal we cannot offer so good a commentary as the following curious extract from the 15th page of his well-written life, by the earl of Buchan and Dr. Minto, printed at Perth in 1787.

Sir Thomas Urquhart, of Cromarty, (the biographer of the admirable Crichton) in his Jewel, "after having referred his readers to his trigonometrical work intitled *Trissotetras*, for the praises of Napier, thus mentions" "an almost incomprehensible device, which being in the mouths of the most of Scotland, and yet unknown to any that ever was in the world but himself, deserveth very well to be taken notice of in this place; and it is this:—He had the skill, as is commonly reported, to frame an engine (for invention not much unlike that of Archytas's dove) which by virtue of some secret springs, inward ressorts, with other implements, and materials fit for the purpose, inclosed within the bowels thereof, had the power, if proportionable in bulk to the action required of it, (for he could have made it of all sizes) to clear a field of four miles circumference of all the living creatures exceeding a foot in height that should be found thereon, how near soever they might be found to one another; by which means he made it appear that he was able, with the help of this machine alone, to kill thirty thousand Turks, without the hazard of one Christian. Of this it is said that (on a wager) he gave proof upon a large plain in Scotland, to the destruction of a great many head of cattle and flocks of sheep, whereof some were distant from other half a mile on all sides, and some a whole mile. To continue the thread of my story, as I have it, I must not forget, that when he was most earnestly desired, by an old acquaintance and professed friend of his, even about the time of his contracting the disease whereof he died, that he would be pleased for the honour of his family, and his own everlasting memory to posterity, to reveal unto him the manner of the contrivance of so ingenious a mystery;

tery; subjoining thereto, for the better persuading him, that it were a thousand pities that so excellent an invention should be buried with him in the grave, and that after his decease nothing should be known thereof; his answer was, "That for the ruin and overthrow of man there were too many devices already framed, which, if he could make to be fewer, he would with all his might endeavour to do; and that therefore, seeing the malice and rancour rooted in the heart of mankind will not suffer them to diminish the number of them, by any new conceit of his, they should never be increased." Divinely spoken truly!"—*Urquhart's Tracts, Edinburgh* 1774. 8vo. p. 57.

IV. To justify lord Napier's *fourth* proposal, not to *certify* it, but merely to abate from its apparent incredibility, to ordinary minds, the reader may refer to the 58th and nine following articles of the ever memorable marquis of Worcester's Century of Inventions. They are all in some measure kindred devices to those of Napier; and one of them (the 64th) the noble inventor says, was tried and approved before king Charles I., accompanied by one hundred lords and commons.

V. The concluding paragraph of the memoir before us contains nothing specific, except "devices of sailing under the water." And some years after the date of this memoir, perhaps during the life of its noble author, this mode of sailing appears to have been successfully exemplified; but whether in the way or ways known to Napier, no historical documents authorizes us to say*. All that we know with any certainty is, that the famous Dutch philosopher Cornelius Drebell, the reputed inventor of the microscope and the thermometer †, constructed for king James I. a subaqueous vessel, which he tried on the Thames, and which carried twelve rowers, besides some passengers, for whom the effete air was again rendered respirable by a liquor the composition of which Drebell never would communicate to more than one person, and that person told Mr. Boyle what it was ‡.

The next subaqueous navigator seems to have been the marquis

* Saverien *Diction.* art. *Vaisseau Urinatoire.*

† See Saverien's *Diction.*, articles *Microscope* and *Thermometre*; also Bossut, *Hist. Gen. de Mathem. per.* iii. *ch.* 6., an interesting work, which has lately been translated by Mr. Bonnycastle.

‡ See Boyle's Exp. Phys. Mech. of the Spring of the Air; also Hutton's Dict., art. *Diving*. De Coetlogon, in his Univ. Hist. of Arts and Sciences, art. *Diving*, ridicules the accounts given of this liquor by Boyle and Chambers, and says he "would be apt to imagine that Drebell's liquor

marquis of Worcester. The articles of his Century of Inventions, in which he makes mention of his contrivance for this purpose, are the following :—Art. IX. "An engine, portable in one's pocket, which may be carried and fastened on the inside of any ship, *tanquam aliud agens*," (as if one was doing something else) "and at any appointed minute, though a week after, either of day or night, it shall irrecoverably sink that ship." Art. X., "A way from a mile off, *to dive and fasten a like engine to any ship*, so as it may punctually work the same effect either for time or execution."

In Saverien's Dictionary, article *Vaisseau Urinatoire*, we read that Dr. Papin endeavoured to recover the lost invention of Drebell, and that he has described a submarine boat in his *Fasciculus Dissertationum*; but whether or not this boat was ever tried, we are not told.

Claudero (as he called himself, for his real name was Wilson) a minor poet, who, about 30 years ago, *flourished* in Edinburgh, by writing satires, or rather lampoons, dedicates one of his pieces, which I read with much pleasure when a boy, to his scheming countryman Peter Williamson *. Among other reasons for his chusing that *great* man for his patron, the poet mentions, or in truth ridicules, his proposal for opening a *subforthian* communication between Leith and Kinghorn, without the tedious formality of waiting for wind and tide. Hence it is probable, that Williamson had proposed or attempted this species of navigation.

liquor was nothing more than spirit of nitre rectified in an extraordinary manner." But modern chemists will be apt to consider De Coetlogon's remark as equally ridiculous with those which he laughs at.

* Williamson certainly was a man of genius or mental resource. As his life has never appeared, at least in any respectable form, the reader will probably pardon the insertion of the following particulars, which I believe are pretty correct:—Peter Williamson was stolen when a boy from Aberdeen—sold in America, for his passage—married, or ran away with his master's daughter—settled in the back country—had his house burnt, and his wife and family murdered by a party of Indians, who seeing him a stout man spared his life, and, loading him with the most portable of his own effects, marched him to their village—lived there for several years in the Indian style—tired of this mode of life—eloped and returned to Scotland, where he found means to bring such of his kidnappers as were alive, to punishment—went about the country with models of Indian canoes, dresses, tomahauks, &c., exhibiting himself in the Indian costume, and explaining their mode of warfare, &c., &c.—His war-whoop and death-holla (or *hollow* as he called it) were horrible.——Peter had many schemes, but I have not heard that any of them succeeded, except the Penny Post-Office at Edinburgh, of which useful institution he was the founder. Government afterwards took it into their own hands, and allowed him an annuity.

vigation. I have understood too, that the respectable and patriotic Mr. Miller of Dalswinton, who, some years ago, made several expensive experiments at Leith, for the improvement of shipping; also contrived a submarine vessel, with what success I have not heard. But either or both of these facts might be easily ascertained, were it worth while.

About 30 years ago, a Mr. Day, after a submarine adventure, which was in some degree successful, made a second attempt, I think at Plymouth, but never appeared again upon the surface. The particulars are detailed in the Annual Register, or some similar compilation.

The fourth volume of the American Philosophical Transactions contains a more interesting detail of this kind. The 37th article is intitled "General Principles and Construction of a Submarine Vessel, communicated by D. Bushnell of Connecticut, the inventor, in a letter of October 1787, to Thomas Jefferson, then minister plenipotentiary of the United States at Paris." Mr. Bushnell affirms, that one of his operators actually brought his boat under a British fifty gun-ship, lying near New York; but the screw (for attaching to the ship's bottom the magazine containing 150lbs. of powder, to be fired by clock-work, which would go 12 hours, if necessary) happened to strike upon iron, and the man, in moving the apparatus, lost the ship. Mr. Bushnell further states, that in 1777 he made an attempt on the Cerberus frigate, lying at anchor near New London. The frigate escaped: but his machine, which was conducted by a line, without any person on board, exploded and totally demolished a schooner, which was concealed from his view by the frigate, and received the shock intended for the latter. In the same year one of his machines, which was calculated to go off by a slight touch, was directed against some British shipping in the Delaware, but was intercepted by a boat, which it destroyed. Mr. Bushnell says that his apparatus was contrived in 1771, but not finished till 1777, when, happily, as it would appear, for many British vessels, circumstances prevented him from bringing his ship-destroying scheme to that perfection of which he plainly saw it was capable.

Such schemes, however, are far from being abandoned. M. St. Aubin, member of the Tribunate at Paris, published, about 18 months ago an account of a diving-boat, invented by a Mr. Fulton, another American. This boat, if we may implicitly believe the description, which other accounts of the kind certainly render credible, will be truly formidable to the ships against which it may be employed.

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We are told that Mr. Fulton was then constructing a boat sufficient to contain eight men, with provisions for 20 days and air for 8 hours, and strong enough to bear submersion to the depth of 100 feet, if necessary. At Havre (in a boat, as would seem, of an inferior size) Mr. Fulton remained an hour under water, made half a league of way in that time with his boat horizontally situated, and at various depths, where he found that the compass traversed exactly as on the surface. To his boat he attached a machine by means of which he blew up a lighter in Brest harbour. When above water, Mr. Fulton's boat is rigged with two sails, and has exactly the appearance of a common boat *.

Though my comments have already been pretty copious, I cannot quit the subject without adding some remarks which obviously arise out of it. In the first place, from our quotation from sir T. Urquhart, it appears that Napier, before his death, which happened in 1617, far from viewing his inventions as either "profitable or necessary," thought them only worthy of that everlasting oblivion to which he endeavoured to consign them. It is curious to observe that sir Isaac Newton, his great successor in mathematical pre-eminence, expressed to Dr. David Gregory, the astronomer, the same strong disapprobation of all such destructive contrivances; as we learn from the additions which his nephew, the late Dr. Reid, of Glasgow, made to the life of Dr. John Gregory, prefixed to his works printed at Edinburgh in 1788†.

Cervantes, who puts much excellent morality and philosophy into the mouth of Don Quixote, a wise man in every respect but *one*, makes him say that "he verily believes the inventor of artillery is now in hell."‡ Milton, in the "Paradise Lost," ascribes the invention of cannon to the leaders of the infernal legions; and Dean Swift, in his travels of Gulliver, reprobates, with his usual severity, our perversion of geometry, mechanics, and chemistry, to the discovery of the means of mutual destruction.

But notwithstanding the opinions of these great men, which do infinite honour to their humanity, it is now generally agreed, that the modern battles with fire-arms, discharged at a distance, in the midst of smoke and without passion, are far less sanguinary than the close, we may say *personal* and angry, combats of the antients; except when

* See the European Magazine for April 1802, p. 245.

† See also Dr. Hutton's Dictionary, article *Gregory*.

‡ See Smollet's Quixotte, vol. ii, p. 152.

decided

decided by the sword, pike, or bayonet, which, no doubt, produce as great animosity and carnage now as weapons of the same kind did formerly. At any rate, it is probable that there is not a philosopher or a christian now in this kingdom, who would object to any improvement in the art of dispatching *an invading foe*. Certain it is that our enemies, even in the highest paroxysm of their rage for philanthropy and fraternization, did not scruple to adopt the improvement of great guns, by the late ingenious and learned professor Anderson, of Glasgow, to which they owed many of their victories.

Whether Mr. Gillespie's new-invented batteries, by means of which he engages to protect the whole British coast with no more than twenty thousand men, may prove as valuable a defensive expedient as Mr. Anderson's has been a terrible offensive one, I pretend not to say. I have, however, just seen a letter from Lieutenant General Hugh Debbieg, colonel of the Royal Invalid Engineers, containing his opinion of it: "Though I cannot," says that professional gentleman, "altogether subscribe to the very extensive application which Mr. Gillespie seems to think his machine may be put to, yet I am most firmly of opinion it may be found of superior utility on many particular spots, and on a great variety of occasions, and, as such, that it ought to be adopted by His Majesty's servants. I have no manner of hesitation in declaring my most ardent wishes that, for the good of the King's service, such measures may be taken as may prove effectual in preventing him, with his model, from going out of this country, to seek the well-earned recompense for an invention of such transcendant merit."

If Lord Napier, it may be asked, made such discoveries, how came they to be neglected and forgotten? The answer has been anticipated: Napier himself neglected them, and wished them to be forgotten. But it may be asked in return, How came the inventions of the marquis of Worcester, one hundred of which were publicly offered to the Parliament, and some of them tried and approved by many of its members, suffered, after all, to be lost to the nation and to mankind? Several of those inventions were, no doubt, more curious than useful; but their value in the aggregate, may, in some measure, be estimated by considering how many metallic veins, otherwise inaccessible, the steam engine (the 68th of the marquis's century) has converted into sources of employment and wealth; and how much has been saved in the labour and maintenance of horses, since the ingenious Mr. Watt, of Glasgow, applied that engine as a moving power to

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machinery. The steam-engine was re-discovered by Thomas Savery, Esq. treasurer to the Sick and Hurt Office; and the telegraph (the subject of the marquis's sixth and seventh articles) by Dr. Hook, as has been already proved *. But most of that great collection, it is to be feared, will long remain undiscovered,—monuments alike of the marquis's superior genius, and of the barbarous stupidity of his cotemporaries in neglecting such a treasure.

⁎ Should the reader observe that I have taken no notice of bishop Wilkins in what I have said of sub-marine navigation, I can only say, that though the Mathematical Magic was lying before me, I unaccountably overlooked it, till the printer had advanced too far to admit its being quoted in the proper place. But this omission is of the less consequence, as the fifth chapter of the bishop's second book, which is employed on that subject, is chiefly speculative and hypothetical, some part of it indeed extravagantly so. I must except this sentence—"That such a contrivance is feasible, and may be effected, is beyond all question, because it hath been already experimented, here in England, by Cornelius Drebell." This positive assertion of bishop Wilkins is of the more importance, as Drebell's experiment was probably made in his own life-time; for he was born in 1614, above twelve years before Mr. Boyle†, and within the limits of king James the first's reign (1603 and 1625), when that experiment was made.

When the above was almost printed off, I lighted on a quotation from an old author, which threatens to deprive Napier of the priority of his proposal for exciting combustion by the solar rays; and two passages, which will tend to give us new views of the invention of the telescope. But probably your readers, as well as myself, have enough of such subjects for the present. *D.

VIII. *Observations on Dr.* Wollaston's *Statements respecting an Improvement in the Form of Spectacle-Glasses. By* William Jones, *Esq. F. Am. P. S. Optician, Holborn.*

Observing, in your Magazine for last month, that Dr. H. Wollaston, by a paper inserted therein, is attempting to introduce into the construction of spectacles, the well-known and

* Phil. Mag. vol. i.

† See Dr. Hutton's Dictionary, articles *Boyle* and *Wilkins.*

and obsolete form of lens, called a *meniscus*, instead of the common glasses, I beg leave, sir, to offer through the same channel a few observations on his arguments; and my opinion why I do not consider the contrivance entitled to any claim, either to novelty or improvement.

When a printed book, or other object, is viewed through a convex spectacle-glass, or other lens, of a short focal distance, such as seven inches down to four inches, or less, the indistinctness observed of the surrounding parts, when the central appears clear, arises from the spherical figure of the lens, and is, by opticians, called the longitudinal aberration of the lens. There is another kind of aberration connected with this lens, called the lateral aberration, which is occasioned by the prismatic form of the lens, producing a different refrangibility of the rays of light, and blending the prismatic colours with their appearance of the object. It is the longitudinal aberration only that I have now occasion to consider. This aberration in lenses of the same foci increases with their diameter and thickness, and of the same diameter, is, in the inverse proportion to the foci.

The rays issuing from distant objects, are more parallel to each other, when incident upon the lens, than proximate ones; therefore the aberration will be less.

Hence it may be inferred, that when spectacle-glasses are made larger in diameter than the angular extent of objects to be seen through them require (a person in that case, without much inclining the axis of his eyes, or feeling it inconvenient, moving his head a little), they have very properly been reduced somewhat in diameter, the aberration being diminished, and consequently the objection, in a great degree, removed, except in glasses that are of very short foci.

In concave glasses the aberration, or indistinctness, is of a similar nature; the defect of these being from the imperfect divergence of the rays, instead of the imperfect convergence by convex glasses.

Spectacle-glasses are now generally made of the double concave and double convex kinds, or nearly so; for a little alteration of figure does not affect the general appearance of objects viewed through them. It is in science as in other cases, that a general utility does not always depend upon trifling alterations. Spectacles are recorded to have been invented about the year 1300, and from reading, and many years experience in this small but invaluable article, I really do not know that during the elapsed time, an optical instrument of any kind whatsoever has undergone more innovation and attempts at improvement. Of many to my knowledge I shall

shall only select the following as entitled to any degree of commendation—*Ayscough's* crown-glass spectacles, the bisected glasses of *Dr. Franklin*, the visual glasses of that learned optician *Mr. Martin*, the square convex form by *Storer*, the patent combined glasses of Messrs. Watkins and Smith, injudiciously called Achromatic, consisting of a convex lens combined with a meniscus or concavo-convex lens. In the mountings of the frames a still greater variety could be enumerated.

Notwithstanding these contrivances, universal experience has caused the original and simple form of glasses to supersede them; and it affords an indubitable proof that it is the best and most convenient that can be contrived, when clear glass, accurate tools, and good workmanship, are used. The theorem given by *Huygens*, and demonstrated by many other subsequent writers on optics, proving that a convex lens, having its radii of curvatures in the proportion of one to six, contains less aberration than any other form of lens, when the greatest convexity is towards the object; and the same for the concave lens must hold true for any use whatsoever for which such a formed lens may be required.

It does not appear to have occurred to Dr. W. that the eye-glasses used to magnify the images formed by the object-glasses in telescopes are of the best form, when with the curves of the proportion above mentioned. In the eye-pieces of the best achromatic telescopes they are always applied, and, in high powers, the image frequently subtends an angle from the centre of the eye-glass of sixty degrees or more. I have never seen any correct dioptrical theorem that tended to prove that a meniscus, singly or combined, will answer so perfectly the same purpose. The ordinary purposes of vision are very well answered by the common glasses under an angle as large as eighty or ninety degrees; and the best artists or draughtsmen allow, that 60° is as much as a fixed position of the eye ought in perspective to embrace, to convey a just representation on the optic nerve.

To persons the humours of whose eyes are so decayed as to be deficient in the original refractive power, glasses of short foci will to them render the extreme parts of objects somewhat confused, but in a much less degree than to persons with perfect eyes or undecayed humours.

In telescopes and microscopes the aberration is usually cut off by the insertion of circular apertures or stops, but in spectacles this is not essentially necessary, nor does the want of them, nor the figure of the glasses, prove that they are constitutionally bad and prejudicial.

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The observation of Dr. W., that only a portion of the glass a little larger than the pupil of the eye is employed at once, is only just in as much as it relates to the mind being intent on a point of an object, but not so in regard to a general view; for the refractive power of the lens does most admirably collect all the infinite number of pencils of rays or cones into one assemblage at the pupil of the eye, where they cross or intersect each other: yet such is the exquisite subtilty of light, that no confusion or irritation takes place. Man is thus blessed by assisted vision, as he is in vitality by the respiration of air. Dr. W.'s inferring the form of a meniscus from the shape of a globe is manifestly erroneous, and in respect to spectacles inappropriate: a glass globe or sphere, without any sensible thickness, to an eye exactly placed in its centre admits all the incident rays to pass through it unrefracted. If the eye deviates from the centre, a refraction will take place, and that in proportion to the thickness of the sphere. Rays of incidence pass perfectly unrefracted through a true ground plane or parallel glass to an eye before it; and let the axis of the eye be ever so much inclined, unless the glass be very thick, the object will still appear perfect, and no refraction of the incident rays be observed. It is obvious, therefore, the nearer a lens approaches to the figure of a plane, the more perfect it must be.

The figure of a meniscus, which Dr. W. wishes to adopt, is as different from a sphere as a plane. Its figure is composed of two positions of spheres, of different radii. When with a positive focus, it is mathematically demonstrable that it has entirely the properties of a convex lens, and, with a negative focus, the properties of a concave one. When the radius of the exterior curve is less than that of the interior, it is a convex sort of lens, and magnifies; but when the radius of the interior curve is less than that of the other, a concave lens, and diminishes. It has also been demonstrated, that the nearer the form of the meniscus approaches to that of a plano-convex or concave, the more perfect it will be, and contain less aberration.

I shall dispense here with proofs by algebraical and analytical formulæ, as any qualified reader will find them in the optical works of *Huygens*, *Molineux*, *Euler*, *D'Alembert*, *Smith*, *Emerson*, *Martin*, and many others.

The rays of light issuing from a near object to a spectacle-glass before the eye are in diverging pencils or cones, and the meniscus form of glass, of any certain positive focus, will refract them towards a state of parallelism into the eye neces-

necessary to produce distinct vision in decayed sight precisely in the same manner as a double convex, or plano-convex. A meniscus, with a negative focus, acts noways differently from the double or plano-concave glasses, the rays of light being diverged somewhat to counteract the effects of too great a convexity in the humours of the eye of a short-sighted person. Perhaps it is hardly necessary to observe, that imperfect vision in the optical sense consists, in the long-sighted eye, in the rays of light not being sufficiently converged by its humours to meet on the retina of the eye, but fall beyond it; and in a short-sighted eye by the rays converging too much, so as to meet before they reach the retina.

Varying the geometrical figure of a lens does not constitute any new optical principle; for any of the common species of lenses may be cut into the form of a square, a triangle, an oval, &c., all figuratively various, but consisting only of one optical principle.

The use of the meniscus has been abandoned by opticians, by its containing, in comparison with other lenses, the greatest spherical surface, and consequently producing the greatest aberration. Reducing the curvatures of the meniscus elongates the focus, and the same manner as in other lenses, and therefore reduces the aberration. Hence, in spectacle-glasses that are not of short foci no perceptible difference will be found to persons unacquainted with optical experiments. There are various practical methods that will point out to persons the aberration of lenses here spoken of, and that the meniscus causes the greatest of any of the other form of lenses; but the following I recommend as the most easy and illustrative:

Take a meniscus lens about the size of a spectacle-glass, and with four inches positive focus, and take also a plano-convex, or a double convex of the same diameter and focus, in a room with one lighted candle; at a distance, by night, hold the convex glass near to the white wall or wainscot side of the room; between it and the candle move the lens backward and forward, till a clear image of the candle be formed, which will be a distant inverted image of it. Do the same with the meniscus, and there will be this difference observed in the meniscus, that, encircling the vivid image of the flame, there will be a faint white light, which is the circle of the aberration. These evidently show that the meniscus is the worst form of the two for a spectacle-glass or any other purpose.

If a person places a meniscus spectacle-glass before his eye of a long focus, and views, towards its extremity, one or more lighted candles, he will observe the flames tinged with prismatic colours, but not so with the usual convex glass. In this position both the effects of longitudinal and lateral aberration are produced.

Two double convex glasses placed together in one cell contain less aberration than one glass of the same diameter and focus; and two plano-convex glasses, with their convex sides placed together in one cell, give still less aberration. It is loss of light only that can be objected to. They are too weighty to be adopted in spectacles, but in the eye-pieces of large telescopes for viewing celestial objects they have been used to great advantage. To the engravers, miniature-painters, and other artists, they are most useful, as, by short foci, and large apertures, they give them the most distinct view of a large surface placed before them.

For the satisfaction of any intelligent person who may be disposed to have an ocular proof of the properties of glasses, as herein advanced, I have constructed a frame containing a double convex, a plano-convex, a meniscus, and two plano-convexes with their convex sides to each other, all of the same diameter; and by which may be seen that the greatest peripheretical indistinctness is with the meniscus glass.—This apparatus will be shown by application at our manufactory in Holborn.

The meniscus, as a figure for a spectacle-glass, I consider very objectionable. To afford a large field of view its diameter must be considerable, which, for a short focus, will increase thickness, protuberance outward, and weight, and, in concave glasses, occasion the frames to be made thicker. The glasses will be more liable to be scratched and broken than those of the common form, and, when the frames are metallic, more liable to increase than diminish that indelible mark made on the nose by the weight of the frame, so frequently complained of by persons who wear spectacles constantly. A great deal of superfluous light also passing through the glasses must be evidently prejudicial; and it appears to me that the concave figure of the inner side of the meniscus will act as a powerful reflector to condense the rays of light and heat upon the eyes, and ultimately prove thereby of serious injury.

I have in my possession a meniscus spectacle-glass, taken from a spectacle frame, which I can prove to have been made a great many years ago: and finally, as it is neither new

new in principle or in practice, I am at a loss to know upon what sort of discovery his majesty's letters patent have been solicited.

I am, Sir, your's, &c.

To A. Tilloch, Esq. WILLIAM JONES.

IX. *Thirteenth Communication from Dr.* THORNTON, *relative to Pneumatic Medicine.*

Feb. 21, 1804.
No. 1, Hinde-street,
Manchester-square.

To Mr. Tilloch.

SIR,

In no instance has the triumph of pneumatic medicine been more conspicuous than in putrid fever; a disease which destroys at all periods of life, and becomes a national calamity when its direful ravages spread from town to town, filling all parts with desolation and dismay, and even sometimes extending from empire to empire.

A Case of Typhus, or Putrid Fever.

Miss Corp, at sixteen*, the amiable niece of alderman Price (late lord mayor), daughter of Mr. Corp, an eminent practitioner, of Barnet, who had seen typhus fevers in both the East and West Indies, and was upwards of thirty years established in extensive practice in that part of the country where he now resides, after every means that human sagacity could devise, found symptoms at length of approaching dissolution arrive to his daughter. In the same fever a neighbour, a few doors off, was now a corse, leaving behind him a wife and six children. This daughter was a beloved child, and so that when the father was requested to see to his patients and business, Mr. Corp refused all abstraction from his attentions, and with the most poignant sorrow, at an advanced stage of the disease, was publicly obliged to declare to the numerous inquiries which were made, "that every hope was now vanished." The lady was convulsed throughout; the tendons were in constant action; the countenance was sunk; and the eyes fixed and ghastly. Mrs. Corp, and the persons in the house, requested the father to leave the room,

* The reader will recollect this case was briefly published before in our Magazine, vol. iv, with a letter from Mr. Corp, of Barnet, confirming the contents; the young lady, since that period, being in the enjoyment of good health: but the valuable observations herein added, with the cure performed in 1793 are fresh articles, and open a glorious field for philosophic considerations.—EDIT.

 and

and suffer the young lady to expire in quiet: and the reluctant parent having retired, on a sudden he roused from his despair, and said, "he would set off for Dr. Thornton directly in a chaise, to try what the vital air could accomplish." The chance of her dying before he could arrive was urged; but Mr. Corp was bent upon it, and he came in violent haste to me. I was out: but he soon followed himself where I was gone, and found me. I made no delay to prepare the apparatus: a balloon of silk with a pipe for the insertion and emission of the air, a bellows to inflate it, and some tin vessels filled with the oxygen gas. The horses were good, the roads fine, and the boy made willing; and soon I reached the house of sickness and despair. She was yet alive, and that was all. The mother requested "I would attempt nothing that would add a pang to her last moments." The nurse, who pretended to be very knowing, said "that my being brought down was a heinous sin; and if Miss Corp was her child I should not be allowed even to see her." Such obstruction we are prepared to meet; and ordering all out who were in the room, except her friend Mrs. Smith, who was weeping by her bed-side, I filled my balloon with nearly equal parts of vital and atmospheric air, and by closing the mouth and one nostril, and inserting the tube into the other, and pressing up the superoxygenated air, watching the times of inspiration, suffering the expiration to be free, this most reviving of all cordials reanimated an almost sunk frame; the subsultus ceased; the eyes became more themselves; the pulse diminished in velocity, and increased in vigour; and when I spoke to her, as did Mrs. Smith, after the inhalation, she appeared to understand, took down a glass of wine, was revived; more air was inhaled, and I quitted the room to tell Mr. Corp of the effects, and for him to give her her former medicines, which she rationally received and swallowed. Having exhausted my air, and written my directions for the night, I remained at Mr. Corp's, and in the morning left his house to come to town to obtain a fresh supply of air, and see my other patients. Upon my return back, towards evening, the same good from the oxygenated air resulted as before, and I pronounced "that my patient would now in all human probability recover." These visits being daily renewed, I had the felicity to restore to her most tender parents, to her friends, and the community, to which, by uncommon virtues and accomplishments, she had rendered herself eminently dear, a young lady whom I do not hesitate to pronounce

pronounce as one out of the many patients rescued from the jaws of death by the powers of pneumatic medicine*.

Another Case of Typhus Fever.

December 1793.—Dr. Beddoes published the following communication I had the honour to address to him.

"I was lately called to a child 13 years old: she had typhus fever, which had attacked two others in the same house. Mr. Murdock, the father of the child, apologized for sending to me when his daughter was at the point of death. Having entered the room, I found her convulsed, speechless, and the eyes sunk, and her breathing extremely laborious. The attendants had even ceased to give her food, nor was medicine so much as thought of. Having placed near her mouth the superoxygenated air, and afterwards filled the room with fine sprays of vinegar, and well ventilated the chamber, she revived to the wonder of all present, took food, afterwards medicine, and finally recovered to the astonishment of every one.

Remarks by Dr. Thornton on these Cases.

1. Putrid fevers are often engendered by bad air alone.

Captain Ellis, late governor of Georgia, in his voyage to Hudson's Bay, gives us the following account from on board the Halifax. The people were all healthy for a considerable time; viz. till the *ventilators* were so spoiled by rats eating not only the leathern but the wooden parts of them, that they became of no manner of use: then putrid fevers appeared, and most of the crew died.

Sir John Pringle, in his work on the diseases of soldiers, gives us likewise numerous examples of the same kind.

The late Dr. Darwin one day at Nottingham assembled a large crowd of people around him, and standing upon a tub, thus addressed himself to the populace.

"Ye men of Nottingham, listen to me. You are ingenious and industrious mechanics. By your industry life's comforts are procured for yourselves and families. If you lose your health, the power of being industrious will forsake you. *That* you know; but you may *not* know, that to breathe fresh and changed air constantly is not less necessary to preserve health than sobriety itself. Air becomes unwholesome in a few hours if the windows are shut. Open those of your sleeping-rooms whenever you quit them to go

* This young lady was cured in 1798, and has continued since that period in perfect health.

to

to your workshops. Keep the windows of your workshops open whenever the weather is not insupportably cold. I have no *interest* in giving you this advice. Remember what I, your countryman, and a physician, tell you. If you would not bring *infection* and disease upon yourselves, and to your wives and little ones, change the air you breathe, change it many times in a day, by opening your windows."

2. Pure air is the antidote against infection.

This is shown from the performance of quarantine.

3. The admission of the purest air is of infinite service in fevers.

I have often heard Mr. Abernethy, a gentleman of the strongest natural sense and most refined intellect, speak with rapture on the benefits he perceived in putrid fever from his patients being placed in different currents of air. "I have always," says the great Dr. Lind, "observed the benefits resulting to the sick in fevers, when removed from the cabin of ships to the better air of Haslar hospital. I have even been informed by a credible practitioner, long resident in Jamaica, that he had frequently seen the poor seamen in the merchants' service to recover from the worst putrid fevers, even the yellow fever, solely by having the benefit of a free and constant admission of the pure sea air into a ship anchored at a distance from the shore, where they lay utterly destitute of every assistance in sickness, and even of common necessaries, having nothing but cold water to drink, and not so much as a bed to lie on; while gentlemen, on the contrary, shut up in small, close, and unventilated chambers, at Kingston, or Portroyal, expired with their whole mass of blood dissolved, flowing from every pore; the bad vitiated air of their room having produced a state of universal putrefaction in the body even before death."

Upon my lamenting, when a student of Guy's hospital, to my learned instructor, Dr. Saunders, that it seemed a cruelty to remove patients in putrid fever, apparently dying, he replied, "I have ever seen that the coming over London bridge has done them infinite service."

4. It appears, that vital air, or some of its combinations, diffused in fever wards, might banish the infection and also cure this disease.

A Fumigation Powder.—Nitre four pounds; sulphur two pounds; southernwood, juniper berries, of each three pounds; tar and myrrh a pound and a half. This was tried at Moscow in 1770, and ten malefactors under sentence of death were fumigated well with this in the Lazaretto, and

and were confined for three weeks in this abode, saturated with infection, made to sleep with persons infected with the plague, and even dead of it; and not one were infected, or made ill of the disease. The vapour arising from the decomposition of nitre by the vitriolic acid is perfectly harmless to be breathed, and may be employed in every situation. This was used by Mr. M'Gregor, after the plan of Dr. Carmichael Smith, who relates, in ten weeks at Jersey he lost in putrid fever 50 men from the 88th regiment; but, beginning the fumigation, not only the fever was banished the hospital, but that it changed the nature of the existing fever; all the malignant symptoms disappeared, and of 64 soldiers ill of the fever not one died.

The subject of air will be renewed in future communications for your excellent magazine, and it is hoped it will rouse the philosophic spirits of more practitioners to the investigation of so interesting an inquiry, which promises the most happy results. In recalling back your readers to the subject of *pneumatic medicine,* I here solemnly declare that I have no other motive than the good of society, and the extension of science, especially that which so intimately relates to the happiness of mankind. I have the honour to remain, Sir,

Your obedient faithful servant,

ROBERT JOHN THORNTON.

X. *On the Influence of the Component Parts of the Soil on Vegetation. By* M. OTTO *.

WHEN the old chemists endeavoured to discover the means by which land could be brought to the greatest possible state of fertility, they imagined that this object could be best discovered by the decomposition of vegetables; and that, from the kinds of earth obtained as a residuum, they should be enabled to deduce what kind of plants would thrive best in a certain kind of soil when enriched with that which is chiefly found in them. That a plant, for example, which contains a great deal of calcareous earth must thrive in particular in calcareous soil, and that another which contains siliceous earth ought to thrive in a sandy soil.

Attempts were made to prove this opinion by experiments, some

* From *Anzeigen der Churfürstlich Sachsischen Leipsiger Oeconomischen Societat.* 1799.

some of which, however, rendered it doubtful. The practical agriculturist has made no use of this doctrine, as he observed in many cases the impossibility of subjecting his fields to so expensive a revolution, and knew, from long experience, that ground without manure produces very little; and therefore he has neglected those works which recommended it.

But the case has been different with the modern chemistry, which perhaps will make us better acquainted with the nourishment and growth of vegetables. By the help of the pneumatic apparatus other principles have been exhibited to us in the vegetable kingdom than those supposed to exist in them by our forefathers. Modern chemistry gives as the component parts of vegetables, carbon, hydrogen, azote, and oxygen, and shows that the existence of earths and metals in the residuum is merely accidental; or at least considers them as doubtful component parts of vegetables. Whether alkalies exist in a substantial form in plants during their vegetation cannot with certainty be determined, as it is highly probable that they may be formed from hydrogen and azote during the decomposition of organic bodies by the help of fire. The native saltpetre found in the *Glecoma hederacea*, *Helianthus annuus*, *Tussilago farfara*, and some species of gourd, and which is obtained from extracts of the above plants, shows at any rate the existence of the principles of these salts, which can only unite when the vital power ceases to act. It is proved, by the experiments and discoveries of modern chemistry, that the separation and union of many principles take place in the course of vegetation. For it is shown by experience, that when plants are irritated in the light or by the light, the water is decomposed oxygen set free, and that they take into them, as a component part, the hydrogen; also that a similar decomposition with the carbonic acid must take place when the plants are irritated by light; for it is only in the dark that carbonic acid is exhaled.

The presence of the fourth principle, azotic gas, in vegetables, is proved by the component parts of the gluten in maize, which by distillation in the dry way gives ammonia; and this, as is well known, can be again decomposed into azote and hydrogen. These principles the plants receive from the atmosphere; for in the atmospheric air with which the plants are continually surrounded azote exists as a component part; and Priestley has proved, by a series of experiments,

ments, that plants can live and grow in pure azote after the first expansion of the germ, which is effected by the accession of oxygen, has taken place.

Besides this proof chemists refer to a well-known and instructive experiment, that plants thrive exceedingly well in willow earth *; and they assert that this earth consists of nothing else than hydrogen, carbon, and oxygen, by which they endeavour to show that the vessels used in the operation, and local and accidental causes, may give occasion to the existence of different kinds of earth in the residua, though they acknowledge that there are plants which contain among their component parts a great deal of pure earth.

From this may be deduced the following consequence; that the requisites for promoting the growth of plants, besides light, heat, and atmospheric air, of which I do not here mean to treat, are good mould, which is indispensably necessary, and which is similar to the above-mentioned willow earth, consisting of matters in part dissolved by putrefaction; and it is certain that land will be productive if covered with such mould to the depth of a furrow. But this pure mould possesses chemical and mechanical properties, in consequence of which, supposing them to exist in the mass, it cannot in many places be either of long duration or useful. It is of a very tender texture, and therefore imbibes a great deal of water; it however as readily suffers it to escape again, and with a moderate degree of drought falls into dust, which is liable to be dispersed by the wind; the water can extract from it the nourishing parts, and where there is the least declivity sweep it away: its volume in regard to the organic bodies from which it is formed is very small, and a considerable quantity of organic bodies are necessary to constitute a moderate sized mass of such earth.

But as the surface of our earth is full of inequalities from which it cannot be freed, and as the putrefying organic matter which can be found is not sufficient to supply the place of that washed away by one shower of rain †, or by an inundation, it will be attended with advantage to mix other kinds of earth with the mould; and experience shows that it is only when organic bodies are in a state of putre-

* The oak and beech produce the same kind of vegetable earth when their interior parts have been dissolved by putrefaction.

† A great deal of wet weather in spring and harvest, say the farmers, drowns the fields, that is to say, washes away and carries off the light soluble carbonic matter of the soil.

faction,

faction, or about to be so, that they are proper for being mixed with it, and the gases disengaged by the putrefaction rendered useful as nourishment for plants; as experience shows that few plants thrive when situated on an accumulation of organic bodies in a state of full putrefaction.

Besides the increased volume, and the advantages connected with it, mould mixed with the bottom earth opposes a greater resistance to wind and water, and thereby secures to the farmer the fruit of the exertion and industry he must employ to reduce organic bodies to a state of putrefaction.

The bottom earth, with which in agriculture organic matters are mixed, does not consist of one kind, but is always mixed with decomposed rocks, as in common it is nothing else, most of which contains silex, argil, lime, and magnesia.

Each of these kinds of earth possesses chemical and mechanical properties which often exercise a contrary action on each other, which does not produce the most beneficial effect on the growth of plants, and therefore it may be of use to the agriculturist to know with what pure earths his bottom earth is mixed.

It would be extending the present essay to too great a length to give a circumstantial description of the process employed by several eminent chemists to decompose vegetable earth; I shall therefore confine myself to an account of the component parts of bottom earth, together with its properties and action, in such a manner that we may thence be enabled to explain from it the views of the farmer in the different operations he employs.

Among the number of the component parts of bottom earth, are:

1st, *Siliceous Earth.*—It appears in general partly in a compact form, as in sand and large fragments of quartz, partly in a fine light form, in which it is more intimately mixed with the other kinds of earth not visible to the eye, and can be separated only by the help of chemistry. It does not every where occur in the same proportion: in many districts it forms, like sand, nearly the whole of the bottom earth, and in others it is scarcely perceptible. Acids, the fluor acid excepted, have no action on it: with alkalies, in different proportions, it forms glass, or the so-called oil of flints, in which union it is soluble in water; and in this state, when it exists, can be taken up very well by plants; in which, however, it forms only an accidental component part.

The mechanical action of this kind of earth, by which it

 moderates

moderates the binding action of clay and loam, is of more importance to agriculture.

2d, *Argillaceous Earth.*—It is equally abundant as siliceous earth, and covers almost alone many districts in the form of loam. It always exercises a binding property, in consequence of which it turns hard in heat, and forms a solid body, the volume of which becomes smaller, from which circumstance the cracking or rending of clayey fields during dry weather may be explained. Water penetrates into it only slowly; and the slower, the drier it was before: but on the other hand, the water evaporates from it again as slowly.

It is scarcely ever found without sulphuric acid, which can be entirely separated from it only by chemical processes, though the water which stands over it can lixiviate a part of it. When in union with sulphuric acid, large fragments of it fall to pieces or effloresce under the action of the atmospheric air.

The binding quality of this kind of earth exercises a prejudicial action in agriculture, as it prevents the roots from penetrating into it; and increases and renders more difficult the operation of tillage.

The solution of black mould, when covered by it in such a manner that the atmospheric air can have no action on it, proceeds very slowly, because atmospheric air, as is well known, promotes and accelerates putrefaction.

3rd, *Calcareous Earth.*—This earth possesses the peculiar property of having a nearer affinity for acids than argillaceous earth or magnesia, and the sulphuric acid prefers it to alkalies: we may therefore with propriety assign to calcareous earth the property of neutralizing acids. Sulphuric acid and calcareous earth produce gypsum, one part of which is soluble in 470 parts of water. Nitric acid and calcareous earth form an earthy neutral salt, which assumes with difficulty the crystalline form, but which in the solar heat can be decomposed into its component parts. It appears that calcareous earth, in certain situations * and proportions, acquires the property of uniting the principle of atmospheric air with nitric acid.

Diluted

* Some months after this was written it was mentioned in the Chemical Journal, No. 6. p. 700-702. "that Mr. Humboldt had discovered that calcareous earth attracts oxygen:" the secret in what manner saltpetre is formed was then discovered. Atmospheric air then contains:

Oxygen	- -	22
Azote	- -	77
Carbonic acid	-	1

And

Diluted nitric acid, as it is highly probable that it is decomposed in the organs of plants as in animal bodies, is not only not pernicious, but advantageous *.

The union of muriatic acid and of lime seems to be of the same nature. Carbonic acid with pure calcareous earth forms common lime, which appears in nature as limestone or as chalk. It is highly probable, and may be explained from the laws of the affinity of the nitrous and carbonic acid for calcareous earth, that they unite alternately with the latter—the carbonic acid in the night, and the nitrous acid in the day.

This holds good only in the warm days of summer: in the autumn and spring the nitrous acid which is formed drives off the carbonic acid, as experience shows in salpetre manufactories. The phosphoric acid forms with it phosphorized calcareous earth.

Burnt lime exercises on animal substances a corrosive quality almost in the same manner as caustic alkali, from which the effect of lime to hasten the begun putrefaction of organized matters in a certain state of moisture may be explained. Hence it is evident that lime always contributes chemically to the nourishment of plants when it is not an essential component part of them. And on the other hand, that too long manuring with lime not mixed with other kinds of manure, as attentive farmers have long known from observation, destroys the good black mould, and so far exhausts the soil: and hence the the proverb—"that it makes the children poor."

Lime can be employed indefinitely only in clayey soil, combined with sulphuric acid, sand, and phosphoric acid, and also where there is a superabundance of black mould.

Turf or peat land, therefore, may be brought to a state of fertility by draining from it the water, and mixing with the turf the requisite quantity of lime.

I may mention, as a mechanical property of lime, that it contributes to render clayey land tender, especially when strewed over it, like marl, in combination with sand.

4th, *Magnesia*.—This earth is very often a component part

And saltpetre:

Azote	-	-	0·64
Oxygen	-	-	0·36

Gough, in his Experiments on the Vegetation of Seeds, mentioned, before Mr. Humboldt, that wet mud possesses in a very high degree the property of attracting oxygen.

* Four ounces of saltpetre dissolved in 48 pounds of water and poured on the roots of carnations, secures them against the rot, and has a beneficial influence on the colour of the flowers.

part of the bottom earth, especially in districts where the latter arises from gneuss or micaceous schistus. Having a greater affinity for the sulphuric acid, it can effect a neutralization of this acid, as it unites with it to produce sulphate of magnesia. In this form, when dissolved in water, it can be conveyed into vegetables, from which we can explain the existence of magnesia in the residuum of the decomposition of plants, without admitting it as an essential component part of vegetables.

5th, *Iron* is found also in some kinds of soil, but never in a metallic form: it is always in the oxidated state in which it is dispersed almost over the whole surface of the earth; with the free sulphuric acid it forms vitriol of iron, which exercises a corrosive action on the roots of plants, and makes them smutty. When dissolved in water in the state of carbonic acid, it perhaps may be capable of passing into vegetables, which explains its being found in them.

6th, *Free sulphuric acid* lixiviated by water from clay occurs here and there: its property of charring the roots of plants is the most probable cause of the production of strata of turf; for the basis of these is always clay and stagnant water, by which the sulphuric acid is lixiviated. The growth of turf may therefore be promoted by not suffering the water to drain off from a dug stratum of it.

Ingenhous recommended manuring with sulphuric acid; and it is evident that it may be of use in calcareous soil, and in the neighbourhood of great cities where the fields are rich in black mould, as the carbonic acid is driven off by it, rendered free, and nourishment thus conveyed to the vegetables: but this method is too expensive to be generally employed.

7th, *Phosphoric acid.* The existence of this acid in animal matters was known: but it is now known that it occurs also in the mineral kingdom, as we are acquainted with a combination of it with iron, to which the cold short property of the latter is ascribed. It is doubtful whether it has any useful influence on vegetation. From what matters it is formed in marshy meadows is not known; but it is believed that it is the cause of the sourness of fodder in places were there is no argillaceous earth.

From the future progress of chemical research there is reason to expect that more effectual means will be discovered of bringing matters back to their original component parts. Phosphorus, sulphur, &c. were for a time considered as substances or principles, merely because it was impossible to decompose them, though there are phænomena which

give reason to suspect that they must be considered as compounds.

8th, *Water* is the most general component part of soil, and indeed, as a medium of solution, it keeps the nourishment of plants in a fluid state, and promotes its circulation; it is decomposed in them into its principles hydrogen and oxygen, and must therefore serve also as nourishment; for the oxygen is expired, and the hydrogen unites itself with the solid parts. But however necessary water may be to vegetation, a superabundance of it has a prejudicial influence on plants, as it softens their fibres, so that the oxygen can easily produce a destructive putrefaction; because they have no longer sufficient elasticity to expire it. Hence the destruction of the crop by water in level fields, where marsh-plants grow up in the room of the corn.

Water lixiviates black mould in some cases, carries off the extractible parts, and renders the ground poor. The influence of water on the sulphuric acid of clayey soil has been already mentioned; and it needs here be only remarked, that it unites more intimately the particles of the clay to the prejudice of the plants, and contributes to form a solid mass, into which neither the roots nor the air can penetrate.

These are the most usual component parts of soil, and though there are other kinds of earth, they have no influence on vegetation, and therefore they may be omitted. It is also needless to mention here that the mixture of the above-mentioned component parts of black mould are not general: on the contrary, that they are mixed according to infinite variations and gradations, and that the sum of the component parts is often not the same in two fields lying close to each other. For these variations and gradations are already so well known that, in the language of the agriculturists, they give occasion to different, often relative, and therefore insufficient appellations. When they speak of sandy, loamy, sharp, hot, heavy, cold, wet, and the like kinds of soil, one may readily conceive from the words what different mixtures are to be understood under the terms sandy, loamy, or wet and heavy soil; when, at the same time, the expressions sharp, hot, cold, denote the same mixtures of soil in different districts. And even if we suppose that a certain fixed idea could be applied to each of these terms, it would be of little service to the practical agriculturist who looks to the improvement of his land. For an appellation, to be proper, ought to express the sum of the component parts, that it may be seen whether the

the soil requires improvement, and in what it consists. For it is only when the mixture of the soil is well known that the farmer can divide his labour into that which relates to the improvement, and that which relates to the preparation of the soil.

XI. *On the Use of Steatites in the Art of Engraving on Stones* *.

THE engraver on stones is in regard to the sculptor what the enameller is to the painter. He labours on a small scale and with difficulty; but his work, when well finished, is delicate and durable. In consequence of the particular value attached to engraved stones, it has often been wished that some matter easy to be worked, and at the same time uniting beauty to solidity, might be discovered. Glass, paste, and that of Wedgewood, are exceedingly valuable; but the impressions formed on them have not the accuracy of the original, and some part of the genius of the artist is lost.

A trial has lately been made for this purpose of steatites, which has perfectly succeeeded, and at present M. Vilcot, an artist of Louvaine, has executed several cameos on this substance. The works of this engraver are well conceived, delicately designed, and beautifully finished. These cameos, which are two or three inches in diameter, are hardened in the fire, coloured and polished. They have then the hardness of flint, the brilliancy of agate, and in colour several of them resemble onyx.

In consequence of its softness this matter can be cut and turned with great facility, and being composed of exceedingly fine parts, the greatest accuracy may be observed in the operation.

This stone is worked in its natural state. It is then put into a crucible covered with a tile, and the tile being luted with clay, the whole, surrounded with charcoal, is put into a furnace. It is exposed to a slow fire, and kept at a white heat for two or three hours: it is then taken from the fire and suffered to cool gradually. The stone by these means becomes very hard; it strikes fire with steel and wears the best files.

The white pieces of steatites in consequence of the heat become of a milky white colour: other pieces assume a gray or ochry colour.

* *Journal des Batimens Civils.*

Steatites, when exposed to heat, may be coloured by solutions in oils, in alcohol, in acids, and in alkalies.

Colours which dissolve in amber varnish, such at verdigris, ochre, &c., communicate their tints to baked steatites: for this purpose it must be heated on a charcoal fire. Colours dissolved in turpentine give a brighter tint.

Solutions in spirit of wine, of carthamus, gamboge, logwood, dragon's blood, &c., communicate their tints to steatites when left immersed in them for some hours.

A solution of gold in nitro-muriatic acid gives to heated steatites a light or a dark purple colour, according to the strength of the solution. Muriate of silver by the help of sulphuric acid gives a black colour. Indigo dissolved in the same acid gives to this stone a blueish gray colour. If steatites, coloured by a solution of gold, or by muriate of silver, be exposed to a strong heat, it acquires a kind of metallic splendor like that of gold or of silver.

When the stone is heated, coloured acid solutions may be applied, so as to produce great brightness and neatness: on this account a particular colour may be given to the ground of the cameo. Sulphuric acid is more efficacious than the muriatic or nitric acids. The oxalic acid may be employed; also coloured alkaline solutions, and particularly that of indigo, may likewise be used: most of the colours sink the eighth of a line into the stone.

When steatites has been baked it is polished with emery and common polishing stones, and also with tin and tripoli: it assumes then a brilliant splendour, and resembles agate, jasper, chalcedony, &c.

This stone, on account of its softness, is exceedingly proper for the purposes of the engraver: by using it he can perform as much work in a day as he could in a week by employing harder stones: he may then by means of heat give his work a great degree of hardness, and render it durable.

Experience shows that the hardness of gems, brilliancy, and the agreeable colours of agate, may be given to the soft and opake steatites, known under the name of lard stone or Spanish chalk.

The artist, who by engraving on gems, immortalizes the image of a great man, or the remembrance of a remarkable event, devotes his talents and his genius to a noble branch of the fine arts. . Cameos and intaglios, therefore, are interesting monuments of the Egyptian, Carthaginian, Grecian and Roman histories. They were objects of study and

5 amuse-

amusement to a Winkelman, a Barthelemy, an Ekel and a Neuman, and are so to the friends and patrons of the fine arts. It is thus that the reputation of Pyrgoteles, Cesari, Coldore, Natter, Pikler, Doell, and other celebrated artists, has been made known and maintained.

The industry and genius of the artist give to cut stones their highest value; but something depends also on the matter and on its preparation.

XII. *Notices respecting New Books.*

The Progress of Maritime Discovery, from the earliest Period to the close of the Eighteenth Century, forming an extensive System of Hydrography. By James Stanier Clarke, *F.R.S. domestic Chaplain to The Prince, and Vicar of Preston. 4to. Volume the First.* (*Pages about* 1000.) Cadell *and* Davies.

We must acknowledge that we opened this volume with considerable prejudice against it, from having previously read an article which appeared in the last number of the Edinburgh Review. Having, however, found our prejudices gradually removed, as we advanced in our perusal of the work, we feel ourselves called upon to declare that we entertain a different opinion from the conductors of that Review, and consider it as a valuable body of information on a useful and entertaining subject.

The laborious and extensive digest of maritime discoveries which Mr. Clarke has formed, will prove of essential advantage to the historian, the merchant, and the circumnavigator. The *first* will find the errors of preceding writers candidly and respectfully stated. The author shows that *Lafitau's Decouvertes des Portugais*, which hitherto has been the principal work to which general readers have resorted for information, is a very flimsy and incorrect account; and that Dr. Robertson, in following its authority, was led into a considerable error, by betraying an ignorance of the first navigator who doubled the Cape of Good Hope. (chap. 2. p. 343.) Herrera also seems to have erred considerably in this respect. The historian will also feel indebted to Mr. Clarke for an excellent *Catalogue Raisonnée* of his authorities, in which are many anecdotes of Ramusio and other writers not generally known; and also for a very valuable list of the principal Portuguese historians, in the

drawing up of which he displays much industry, and a very extensive knowledge of bibliography. The hitherto celebrated *Histoire Générale des Voyages*, is now found to have been a literal translation, as far as the seventh volume, and part of the eighth, from a general collection of voyages and travels, in four thick quartos, printed in London, for a bookseller of the name of Astley, and compiled by Mr. John Green. The merchant will peruse this volume with interest from the information it necessarily affords relative to maritime commerce. Instead of the trite and confused account of the Phœnicians, whom preceding writers have considered as the first promoters of commerce, Mr. Clarke refers his readers to maritime traders of much higher antiquity; and after favouring them with an abstract of Mr. Bryant's sentiments respecting the Noachidæ, the Amonians (a name which comprehended all nations known as inhabitants of Egypt, of Phœnicia, or Canaan) the Cuthites, the Anakim, the Titans, the Scythæ, and the Atlantians; he clearly traces the progress of maritime nations from the Indian Ocean to the shore of the Red Sea, where the Edomites, the ancestors of the Phœnicians, formed their first settlement at Mount Seir. (Sect. 2. p. 67.) Mr. Clarke then enters on the maritime history of the Hebrews, in which the country of Ophir is considered, and the term Tarshish; the former he is inclined to think, with Bochart, was Ceylon, and that by Tarshish was meant the Sea, in its most extensive signification. (Sect. 2. p. 84.) He then concludes his account of the sacred periods of maritime history with a refutation of the Phœnician Periplus of Africa. The maritime discoveries of the Greeks are detailed with considerable interest from a variety of learned writers, whose rare and expensive volumes can only be procured at a considerable expense and difficulty. Costard's excellent, but long neglected History of Astronomy, is justly appreciated by Mr. Clarke; and the Athenian commerce on the Euxine, is given from his grandfather's learned work, the connexion of the Roman, Saxon, and English coins. At the same time, however, that our author thus collects and combines the opinions of different writers, which we must acknowledge is done in a fair and candid manner, he occasionally favours and relieves the reader with such original remarks as the nature of the digest he had in view would admit. The naval character of the Greeks is thus described:—" The professional character of Grecian seamen was influenced by the manners of the different states to which they belonged; and it therefore fluctuated on an

 extensive

extensive scale, from the cold or forbidding policy of the Lacedæmonians to the capricious yet captivating disposition of the Athenians. The first was too haughty and austere to gain the hearts of those who served; the other of too unequal a temper to secure or reward the enterprising spirit of those who commanded. Even among the Athenians, the naval character had not sufficiently emerged from the warehouse of their merchants; and at Lacedæmon, where the highest object of ambition was a command in the cavalry, that valuable nursery for seamen which the honourable avocations of commerce furnish was purposely neglected. The iron coinage of Sparta shackled the speculation of its inhabitants; and when Lycurgus prohibited navigation and commerce throughout an extent of coast that furnished so many excellent harbours, he proved how impossible it was for a rigid moralist to entertain a due conviction of these liberal principles which are essential to the character of a legislator." (Sect. iii. p. 123.) The fourth section brings into one point of view all that has survived respecting Carthaginian and Roman maritime discoveries; the voyages of Hanno, of Himilco, of Polybius, of Sertorius, of Juba, of the freedman of Annius Plocamus, and the Periplus of the eastern coast of Africa, are introduced with considerable judgment, and well connected with each other. The whole of this introductory part is closed by a dissertation on the commerce of the Romans by the author's learned grandfather, which hitherto has not been generally known.

Mr. Clarke then enters on the principal subject of the volume; and in his first chapter gives a general view of the maritime history of Europe and of Portugal, to the beginning of the fifteenth century, when the Portuguese discoveries first began. The second chapter continues the history from the accession of John, the first king of Portugal, to the discovery and doubling of the Cape of Good Hope by Bartholomew Diaz; and the third chapter closes with the arrival of Da Gama on the coast of Calicut, on the 20th of May 1498. The valuable appendix that follows, contains some scarce treatises connected with the subject of the work, among which a history of navigation, by the celebrated Locke, particularly attracted our attention.

We shall now only proceed to notice some of the many philosophical facts which are dispersed throughout the volume, which is enriched with numerous engravings of the coast that comes under consideration; and with an excellent set of charts by Arrowsmith.

 One

One essential merit in this work is, the liberal and extensive manner in which the opinions of preceding writers are detailed; and the impartiality which Mr. Clarke observes in leaving the reader to form his own opinion from the facts that are adduced. We perceive no attachment to system, or preconceived opinions; no invidious aspersion even when considerable errors are detected; no wish to steal the thoughts of other writers and disguise them under a new form of expression. The mariner's compass, from the evidence which Mr. Clarke adduces, was certainly first known and used in the Indian ocean, whence it was introduced into Europe as a new discovery. It is assigned by professor Assemani, of Padua, to the Arabians, (Introduction, p. 9, note;) and Mr. Clarke has brought strong proof to show that the flower which marks the North, and which has erroneously been called the *fleur de lis*, was in reality the Indian lotus. Dr. Hyde, in his treatise *De Religione Veterum Persarum*, affirms that the Chaldeans and Arabians had immemorially made use of the compass to guide them over the vast deserts that overspread their respective countries; and according to the Chinese records, as cited by Mr. Maurice, the emperor Chingvang, above a thousand years before Christ, presented the ambassadors of the king of Cochin-China with a species of magnetic index which they called *chinan*; a name by which they at this day denominate the mariner's compass. (*Progress of Maritime Discovery*, sect. i. p. 7.) The earliest allusion to the directive power of the magnet occurs in the Life of Pythogaras by Jamblichus, who asserts that "Pythagoras took from Abaris, the Hyperborean, his golden dart, without which it was impossible for him to find his road." (Ibid. p. 51.) Mr. Clarke thinks that the loadstone, though not used in navigation, was brought by Solomon's navigators from India to Europe; and in support of this cites, on the authority of Mr. Henley, a passage from the 10th chapter of the first book of Kings. (ch. iii. p. 397.) The magnet was mentioned by the most antient classical writers under the name of *Lapis Heraclius*, in allusion to Hercules, who was said to have sailed in a golden cup, given him by Apollo, to the coasts of Spain, where he set up the pillars that bear his name; or perhaps rather from Heraclea, a city of Lydia, where it was discovered. Our author's learned relation, Dr. Wotton, was of opinion that the magnet was known and admired by the antients, but was never employed for the purposes of navigation. (Ibid. pages 177 and 178.) These are certainly very curious facts, which have hitherto been too

too much neglected; and Mr. Clarke deserves our thanks for having presented them to the attention of scientific men. He reserves for a future volume a more particular discussion of this important discovery, which, we doubt not, will, after these remarks of his, be assigned to the Arab navigators on the Indian ocean. In the excellent narrative which he has given of Da Gama's voyage, Mr. Clarke subjoins another proof of the justice of his ideas from a passage in Osorius, the whole of which had inadvertently been omitted in Mr. Gibbs's translation. This early Arab or Moorish compass was found by Gama on his arrival to have been long used by the Indian seamen; and Osorius thus introduces his description of it:—*Utebantur in navigando Normis nauticularis, quas nautæ acus appellant. Quarum formam, propter eos qui a maritimis regionibus remoti sunt, haud alienum arbitror explicare* . . . . The same historian also mentions their early use of the quadrant long before it was known in Europe:—*Quadrantibus etiam, solis varias conversiones, et quantum quæque regio ab æquinoctiali circulo distaret, observabat.* (Progress of Maritime Discovery, ch. iii. note i. p. 451.)

Previous to Da Gama's voyage, Mr. Clarke, very properly, in order to impress the mind of his readers with a just idea of the perils which Gama had to surmount, gives some concise hydrographical remarks on that navigation; and as his work is intended to form (the first time that any one has made the attempt) an extensive system of hydrography, he offers the following simple divisions of the ocean to the attention of nautical men:—1. The North Atlantic, extending from the equator to Cape Farewell on the coast of Greenland in 60° north latitude. 2. South Atlantic, from the equator to an imaginary line drawn from the Cape of Good Hope to Cape Horn. 3. Indian ocean, bounded to the south by a line carried from the Cape of Good Hope to the south-west point of New Holland. 4. The North Pacific, flowing from the equator to an imaginary line stretched from the south-eastern point of Van Dieman's Land to the southern Cape of New Zealand, and continued thence to Cape Horn. The remaining portions of the ocean flowing round the northern and southern poles, to be called the North and South Polar Seas. (Ibid. ch. ii. p. 351.) Among these hydrographical remarks we observe a great many latitudes and longitudes on the western coast of Africa, now first published, which were ascertained from lunar observations by an officer of rank in the king's service. The nature and limits

mits of our journal will not allow us to mark the variety of curious philosophical information which abounds in this useful publication, and shall content ourselves with citing the following curious fact from the author's correspondence. (Appendix, p. 260.) Gama's squadron continued during a whole monsoon at anchor on the coast of Malabar; yet when the English obtained possessions on that coast, a vessel fitted out in India, with the best of ground tackling, and every precaution taken that was possible, was sent to the same place on the approach of the monsoons; but, notwithstanding the superior skill of our seamen, the attempt was found impracticable, and the vessel was driven ashore.

Elements of Science and Art: being a familiar Introduction to Natural Philosophy and Chemistry; together with their Application to a Variety of elegant and useful Arts. By JOHN IMISON. *A new Edition, 2 Vols. 8vo.*

The present work, though, modestly enough, called a new edition of Imison, is intitled to hold a much higher rank. It is in a great measure a new performance, and contains much useful and entertaining matter on a great variety of subjects:—viz. mechanics, pneumatics, hydrostatics, hydraulics, optics, electricity, galvanism, magnetism, astronomy, chemistry, drawing, bleaching, dyeing, metallurgy, varnishing, japanning, lacquering, gilding, silvering, tinning, soldering, moulding, and casting; cements, ink-making, staining of wood, &c., &c., &c.—To those who have not time or opportunity to enter deeply into subjects of the kind embraced by this work, and who yet may wish to obtain information on such matters, it will prove a valuable acquisition; as it contains a great deal in a moderate compass, and detailed at the same time with considerable perspicuity and precision. The plates, thirty-two in number, are by Lowry, and executed in a masterly manner.

XIII. *Intelligence and Miscellaneous Articles.*

GALVANISM.

THE following is a correct and more particular account than any that has yet appeared of the galvanic experiments made by Mr. Carpue on the body of Michael Carney: from notes taken by an eminent physician who was present.

The subject of these experiments was thirty-seven years of

of age; and the body, after hanging the usual time, was conveyed to the experiment-room an hour later than Forster: it arrived at ten minutes past nine.

1st, Oxygen gas was introduced through the trachea at a quarter past nine.

2d, A conductor from a galvanic apparatus, consisting of about a hundred square plates of zinc and copper, about four inches diameter, disposed in three troughs, and which produced visible sparks, being applied to a piece of tinfoil, introduced so as to come into contact with the great intercostal, the par vagum, and phrenic nerves, the other end of the apparatus being connected with the rectum, for ten minutes, a little motion was produced in the lips and the sternal muscles.

3d, Common air being forced from several bladders into the trachea, so as to inflate the thorax, friction being, at the same time, applied, together with the galvanism as before, the face became very black. The apparatus operated in a very powerful manner. At twenty-five minutes after nine, the blackness of the face disappeared: the air contained in six bladders was forced into the lungs, by which the body was considerably inflated.

4th, At twenty minutes before ten, cloths heated by hot water were applied to the thorax; the galvanism and inflation with common air were continued, and again produced blackness in the face.

5th, Five minutes before ten, inflating with a pair of bellows, galvanising, and the application of hot cloths, were continued.

6th, At ten o'clock, a vein was opened in the arm, from which black blood flowed on pressure, as in the state of life; no blood in the temporal artery.

7th, Conductors were applied to the schneiderian artery; increased contractions of the lips and muscles of the face took place. During these operations it was observed that the veins of the arms were distended.

Ten minutes after ten, conductors being applied to the pericardium and the diaphragm, the action of the pectoral muscles was excited.

8th, When applied to the denuded pectoral muscles, strong action was excited.

9th, The lungs were proved to be in a sound state by inflating them with a pair of bellows. The neck had been much injured by pulling and twisting the body round while hanging.

10th, At

10th, At twenty minutes past ten, the left auricle, and more so the right, were excited to action, but not the heart: they continued to act for some time on withdrawing the stimulus; but the action was much increased by applying it from time to time.

11th, One conductor being applied to the sinclavian membrane, and the other to the anus, the action of the auricles was much increased, and motion was, at the same time, produced in the face.

At forty minutes past ten, action was excited in both auricles, but particularly the right.

12th, A large quantity of black blood in the carotid artery.

13th, The body was colder than in the case of Forster; but some deception may perhaps have arisen from the air being much warmer.

The temperature of the external air was about 58°, and that of the room 62°.

EXPERIMENT ON A TOAD.

On the 5th of November 1802, Mr. John Walker, of Bassenthwaite Chapel, in the county of Cumberland, put a toad into a bason, which he covered with a slate, and then deposited it about a foot beneath the surface of the earth. On the 8th of January 1804, the bason was carefully dug up, when its inhabitant was found alive, but reduced in size by its confinement. After the curiosity of the spectators was gratified, the toad was again committed to the earth for a further experiment.—*Cumberland Packet.*

DEGREE OF THE MERIDIAN MEASURED IN INDIA.

It is with pleasure we have to inform our readers of the rapid progress geography is making in the East Indies. Brigade major Lambton, who is employed by the presidency of Madras to survey the Mysore country, has already measured an arch on the meridian, 1° 34′ 56″ 43, which gives the degree in lat. 12° 32′, equal 60, 494 fathoms; and we have every reason to believe the above measurement correct, knowing that major Lambton has been furnished with a six feet zenith, sector, and measuring chains, by the late Mr. Ramsden, and also a three-feet theodolite, by Mr. Cary, similar to that now used by major Mudge in the trigonometrical survey of England.

TRAVELS

TRAVELS, &c.

A letter from Petersburgh, dated October 27th 1803, states that Mr. Benjamin Bergman, after a residence of three years among the Calmuc Tartars, has returned to Riga, where he means to arrange and prepare for the press the observations he collected during his interesting travels. They will soon be published, and will form five volumes. A curious extract from them, on the Calmuc bards, has already appeared in the Northern Archives; and we learn by another letter, that the draftsman Carraffe, well known by his beautiful views in Egypt and Syria, and his large collection of drawings which relate to the manners and customs of these countries, has lately arrived at Petersburgh from Paris, in company with two young Frenchmen, for the purpose of making a tour through the Russian empire, where he will, no doubt, find abundance of valuable materials to form a *voyage pittoresque.*

We are likewise informed that his imperial majesty the emperor of Russia has caused ten thousand copies of a popular treatise on the cow pock, written in the Russian language by the medico-philanthropic society, to be printed at his expense, and to be sent to all the governments for the purpose of being distributed gratis among the people, and particularly in the country.

MINERALOGY.

A very remarkable piece of amber was found lately in a field in the Lithuanian circle of East Prussia, about twelve miles from the shore of the Baltic. It is 13¾ inches in length, and 8¼ inches in breadth. It contains 318 cubic rhinlandic inches, and weighs above eighteen pounds. No person ever remembers to have heard of so large a piece of this substance being either found on the coast, or dug up in the country. The largest piece known, which is in the cabinet at Madrid, weighs only eight pounds. A dealer in amber offered three thousand dollars for it. The king, however, has ordered it to be deposited in the cabinet of minerals at Berlin, belonging to the department of mines, and one thousand dollars to be paid to the proprietor of the estate where it was found; part of which is to be given to the person who found it. Amber is the property of the crown, and is generally sold by auction to the highest bidder.

SINGULAR PETRIFACTION.

A quarrier, in a village near Paris, having detached by means

means of gunpowder a large block of stone, split it by the usual processes, and found in the middle of it the petrified skeleton of a ram. The two sections of the block each contain one half of the animal in perfect preservation, with all the parts exceedingly distinct. The block was detached from the solid rock, at the depth of thirty feet from the summit of the quarry. This curious petrifaction is to be deposited in the museum of natural history.

METEOR.

A very uncommon meteor was observed at Befort on the 22d of September 1803, by L. Ordinaire, correspondent of government for agriculture and meteorology, the account of which we shall here give in his own words:—"At seven o'clock in the evening of that day," says he, "I was returning from the country. The air was slightly agitated by a gentle wind at east-north-east, and it was very dark. At half a league from Befort I saw the heavens suddenly become so bright that the country seemed as if illuminated by a thousand lamps. I immediately perceived a globe of fire which issued from a cloud: it passed over our heads and rushed into another cloud. The globe was of a reddish yellow colour, and exceedingly brilliant. It seemed to be about six or eight feet in diameter. It left behind it some faint traces of light, like those produced in general by common sky-rockets.

"We saw this globe for one minute at least. The horses were so terrified by it that they set out on a full gallop. The coachman himself was frightened, and two ladies were taken ill. When the globe rushed into the other cloud it seemed to revolve, describing a semicircle. I lost sight of it near a wood, at a little distance, where I suppose it exploded, for we heard a hollow noise like that of a cannon discharged at a great distance. This explosion was attended with no bad consequences, for we heard of no damage done by it either next day or the days following.

This meteor was seen at Befort and at the neighbouring villages. The explosion was felt in that town. At first it was supposed to be an earthquake. The glass in the windows was shaken, and the houses experienced a kind of shock which excited great alarm. The globe proceeded in a direction from north-east to south-west. On my return to Befort I examined my barometer, which stood at 27 inches 4 lines, and my thermometer was at 10¼ degrees above freezing.

METEOROLOGY.

Some of our philosophical friends having expressed a desire to see in our work a regular monthly register of the state of the barometer and thermometer, we are happy to have it in our power to gratify them. Mr. Carey, of the Strand, well known as a mathematical instrument maker and optician of eminence in his profession, has kindly undertaken to furnish us with it every month. Our readers may therefore depend on its accuracy.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Weather.
1803. Dec. 27	50°	51°	48°	29·50	Rain
28	48	46	46	28·90	Stormy
29	46	48	52	29·40	Stormy
30	50	54	48	·30	Rain
31	45	47	44	·50	Rain
1804. Jan. 1	38	43	38	·80	Cloudy
2	35	41	32	·90	Fair
3	31	35	32	30·06	Fair
4	30	33	30	·13	Cloudy
5	30	35	30	29·70	Snow
6	29	33	29	·77	Fair
7	28	33	29	·70	Cloudy
8	29	35	35	·69	Cloudy
9	35	40	38	·71	Rain
10	36	43	37	·95	Fair
11	33	40	45	·85	Foggy
12	45	47	47	29·56	Cloudy
13	43	52	51	·25	Rain
14	51	53	52	·40	Cloudy
15	53	55	50	·55	Rain
16	50	56	50	·50	Showery
17	50	54	50	·38	Cloudy
18	51	55	49	·69	Rain
19	48	50	50	·51	Cloudy
20	48	50	44	·22	Fair
21	48	52	51	·45	Fair
22	50	51	48	·48	Fair
23	46	50	49	·76	Fair
24	49	51	49	·36	Fair
25	48	52	48	·40	Cloudy
26	48	51	46	·25	Fair

METEORO-

METEOROLOGICAL TABLE

For February 1804.

Days of the Month.		Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Weather.
1804. Jan.	27	46°	50°	46°	29·04	Showery
	28	49	50	48	28·78	Rain
	29	44	51	44	30·24	Fair
	30	46	49	48	·14	Rain
	31	48	53	47	29·66	Rain
Feb.	1	45	50	45	·51	Fair, rain at night
	2	44	48	44	·55	Fair, ditto
	3	43	47	39	·40	Fair
	4	32	34	32	·55	Fair
	5	30	42	31	·95	Fair
	6	25	31	25	30·08	Fair
	7	26	34	32	·40	Fair
	8	28	39	40	·42	Cloudy
	9	43	46	48	29·98	Rain
	10	48	49	44	·62	Fair
	11	44	49	46	·04	Stormy
	12	41	37	32	·83	Cloudy
	13	30	32	29	30·30	Fair
	14	28	35	29	·35	Fair
	15	28	38	35	·35	Snow showers
	16	35	39	30	·32	Cloudy
	17	29	35	34	·30	Fair
	18	35	39	35	·29	Fair
	19	35	42	36	·28	Cloudy
	20	38	41	39	·35	Showery
	21	38	45	42	·48	Cloudy
	22	41	45	40	·43	Cloudy
	23	38	46	37	·22	Fair
	24	30	44	34	29·82	Cloudy, with hail shower at night

XIV. *Experiments made for the Purpose of ascertaining whether there be a real Acid of Cobalt; or, in other Words, whether Cobalt actually unites with Oxygen to the Degree necessary for Acidification.* *By* C. F. Bucholz *.

No newly discovered substance has been admitted more readily, and with less examination into chemical works, than the supposed cobaltic acid of Brugnatelli, though the experiments from which its existence is concluded were very imperfect and unsatisfactory. As there are several metallic acids, it was natural to conclude, by analogy, from these experiments, that the existence of the cobaltic acid was real or possible: but the defective nature of the experiments, and the importance of the object, ought to have induced chemists to subject them to a strict proof; for the truth of any circumstance can be proved only by the coincidence of repeated experiments made to ascertain it.

Convinced of the truth of this observation, and of the incompleteness and inaccuracy of Brugnatelli's experiments, and of the consequences deduced from them in regard to the cobaltic acid, I undertook some new ones for the purpose of examining them, and thereby ascertaining whether there really be such a substance as cobaltic acid. In consequence of the well known impurity of zaffer or gray oxide of cobalt, which, besides the so called oxide of cobalt, contains arsenical cobalt (perhaps arseniate of cobalt), iron, nickel, lime, siliceous earth, and other foreign matters, I did not think it proper to repeat with it Brugnatelli's experiments, as I had been taught by other experiments, which will be mentioned hereafter, that the phænomena observed by Brugnatelli in the experiments he made with zaffer to produce cobaltic acid, ought in all probability to be ascribed to the arsenical acid of the zaffer. I therefore resolved to begin my experiments by a direct union of pure cobalt with the oxygen of oxygenous bodies; and I had the stronger hopes of a favourable result, if the cobalt was susceptible of this transformation, as I knew from the analogy of other metals susceptible of acquiring the acid state, such as chrome, scheel, molybdena, and arsenic, that the conversion of such metal into acids is exceedingly easy. One experiment however, by M. Fiedler of Cassel, on the forma-

* From Scherer's *Allgemeines Journal der Chemie*, No. 51.

tion of the cobaltic acid from cobalt and the oxygen of nitrous acid, is favourable to the assertion of Brugnatelli; but it is impossible to consider such experiments, results, and deductions, so satisfactory and convincing as to render this subject unworthy of further research. For my part, I am of opinion that they are not convincing or satisfactory; especially as it is not proved in general that arsenic can be completely separated from cobalt, according to the method of Lampadius, by a current of air, or by Fiedler's application of this process.

Experiment I.

Four ounces of nitric acid of the specific gravity of 1·280 were poured over two drams of carbonated oxide of cobalt as pure as possible, equal to one dram of pure oxide of cobalt, and distilled to dryness in a retort. No traces of nitrous gas or nitrous acid appeared, from which it could be concluded that an oxidation of the cobalt or a deoxidation of the nitric acid had taken place. The nitric acid which passed over without any change, was again poured into the retort over the cobalt, and distilled to dryness in a gentle heat, but with the same result. And the same was the case when the process had been repeated four times. The nitric acid remained undecomposed, and the residuum was nitrate of cobalt, from which the oxide of cobalt could be separated as a blue precipitate, both by potash and by ammonia.

Experiment II.

But as it was possible that the precipitate, which had a perfect resemblance to one obtained from a solution of cobalt in muriatic acid, might contain the cobaltic acid, I digested it with pure ammonia: a little cobalt was dissolved, but no traces of acid were found in the solution evaporated to dryness.

Experiment III.

I now evaporated to dryness the fluid from which I had separated the oxide of cobalt by means of ammonia, and which, besides nitrate of ammonia, still contained some redissolved oxide of cobalt. The saline mass thus obtained was of a reddish appearance, and had the taste of an ammoniacal salt with a little metallic astringency. The half of this saline mass being then decomposed by heat in a porcelain dish, the result was a black oxide of cobalt. The other half, being dissolved in water, exhibited no other phænomena with the usual reagents than those which gave reason to suspect some traces of arsenical acid. Though the result of

of these experiments evidently showed that the oxide of cobalt itself could not be converted into an acid by a very large quantity of nitrous acid, and repeating the process several times, I did not consider this experiment as sufficiently decisive. In consequence of this idea I resolved to repeat it, changing the process a little with a greater quantity of materials.

Experiment IV.

Eight ounces of pure nitric acid, of the specific gravity of 1·280, was poured over half an ounce of oxide of cobalt, purified as much as possible from arsenic and iron, and distilled from a tubulated retort to dryness; which was the case in four hours. During the operation there was no appearance of nitrous acid vapours: the liquor which passed over was nitric acid, perfectly pure. The latter was again poured into a retort, and redistilled under the same circumstances. The phænomena during this distillation were exactly the same as before. Having repeated the process with the like result, the saline mass remaining in the retort, which when heated had a garnet red colour, was dissolved in distilled water and evaporated to dryness in a porcelain dish. It then weighed six drams. When dissolved in four ounces of distilled water, the solution was divided into two portions, and subjected to the following experiments:

Experiment V.

One-half was evaporated to dryness, and the saline mass thus obtained was heated in a porcelain dish till the greater part of the nitric acid was decomposed; so that, if any cobaltic acid had been formed, it must have remained with the oxide of cobalt. The residuum had a black and dry appearance, and in the pure state weighed 50 grains. It was digested some hours with pure ammonia, and boiled for a quarter of an hour, by which means 30 grains of black oxide were dissolved, and formed a beautiful ruby red solution. This solution was then evaporated to dryness, and during this operation the dissolved oxide of cobalt was separated in a grayish state. Being again dissolved in distilled water, filtered and evaporated, the faint ruby red colour of the liquor was changed to pale red inclining to yellow, and a grain of oxide of cobalt was in part separated in yellowish brown flakes. The dry saline mass was again dissolved in distilled water, and separated by the filter from the separated oxide of cobalt; after which the solution was once more evaporated to dryness, and for a short time exposed

 to

to an almost red heat. A small quantity of saline matter, amounting to about three or four grains, remained, which according to the different proofs made with it was nitrate of ammonia, and which when dissolved exhibited the same phænomena as those to be mentioned hereafter in the seventh experiment. This no doubt arose from a still remaining trace of the arsenic acid, but by no means from cobaltic acid.

Experiment VI.

The other half of the solution, obtained by the fourth experiment, was decomposed by pure carbonate of ammonia, by which means a pale red precipitate inclining to violet was produced. The precipitate being then edulcorated with a sufficient quantity of water, it was digested with twice as much carbonate of ammonia and half an ounce of pure ammonia, by which means a beautiful violet blue solution inclining a little to red was produced, and there remained 30 grains of oxide of cobalt undissolved in the state of a carbonate. The filtered solution was evaporated in a moderate heat to dryness, by which the ammonia was dissipated, and the oxide of cobalt was separated of a dirty yellowish green colour. When edulcorated and dried, it amounted to 24 grains, and contained less carbonate than the almost imperceptible residuum of the digestion with ammonia. The liquor obtained from the edulcoration of the greenish yellow oxide of cobalt produced by the evaporation of the ammoniacal solution, was evaporated in a porcelain dish, and exposed to a strong heat, but without bringing it to a red heat. By these means a residuum of saline matter weighing scarcely two grains, and some black oxide of cobalt, were obtained. The solution prepared from this substance exhibited the same phænomena as nitrate of ammonia, and even with reagents, as will be further mentioned in the seventh experiment; only it appeared to form with nitrate of silver a somewhat stronger precipitate, which could not be again immediately dissolved, and which probably arose from the muriatic acid of the ammonia employed, as there was reason to suspect from its white colour. From these phænomena it is proved that some traces of arsenic acid were found in the precipitate of cobalt effected by ammonia, but none of cobaltic acid.

It still remained to examine the liquor in which the oxide of cobalt had been separated from its union with nitrous acid

acid by means of ammonia, and to ascertain whether it contained, besides nitrate of ammonia, cobaltic acid. For this purpose the following experiment was made:

Experiment VII.

The above fluid, which contained the nitrate of ammonia, formed in the preceding experiment by decomposing the nitrate of cobalt by ammonia, being evaporated to dryness, the result was a brownish black residuum, which exhibited exactly the same phænomena as nitrate of ammonia. When dissolved in distilled water the solution gradually acquired a reddish colour, and the blackish residuum of oxide of cobalt which remained on the filter did not weigh completely two grains. The liquor exhibited the following phænomena:

It gave scarcely any red colour to litmus paper; it did not produce the least turbid appearance in a solution of sulphate of copper: the case was nearly the same with an ammoniacal solution of copper: nitrate of silver became a little turbid, and in a little time the cloudiness assumed a brownish colour: acetite of lead was rendered a little turbid, but scarcely perceptible, and without depositing a precipitate after long rest: in muriate of barytes no turbid appearance was observed: a drop of nitric acid added to a dram of the turbid fluid occasioned no complete solution.

The phænomena of this experiment prove in the clearest manner, that a trace of arsenical acid, but no real cobaltic acid, was present. This result, and no other, can be deduced from the above experiments; and it seems to be placed beyond all doubt, that cobalt cannot be converted into an acid, at least by treating it with nitric acid.

After these ineffectual attempts to produce cobaltic acid, by treating cobalt with nitric acid, I determined to try Scheele's process for forming arsenical acid; and though I entertained some doubts of obtaining cobaltic acid by this process, in consequence of having considered the circumstances more maturely, and of knowing that the muriatic acid has more affinity for oxygen than cobalt, as the muriatic acid, when it comes into perfect contact with oxide of cobalt, takes from it a part of its oxygen, and is converted into oxygenated muriatic acid, I was desirous of not leaving it untried, and therefore proceeded in the following manner:

Experiment VIII.

A hundred grains of carbonated oxide of cobalt, obtained and collected in the preceding experiments, and which consequently were free from arsenic acid, were heated with three

 drams

drams of muriatic acid of the specific gravity of 1120, and two ouncesof pure nitric acid of 1210, and by continued simmering were evaporated to dryness. From the beginning to the end of the operation, vapours of oxygenated muriatic acid and of nitrous gas were disengaged: the former exactly in the same manner as when muriatic acid is poured over oxide of cobalt not carbonated nor heated to redness. Three drams of muriatic acid and two ounces of nitric acid were repeatedly poured over the oxide of cobalt, and distilled to dryness. The same phænomena took place. The acid solution of cobalt evaporated to dryness was dissolved in four ounces of water, filtered, and decomposed by pure carbonate of ammonia. After the decomposition as much ammonia as was necessary for this purpose was then added, and the whole was shaken for half an hour in a gentle heat. The solution had a blue appearance. It was then freed from the undissolved residuum by the filter and edulcoration, and, being evaporated to dryness, three grains of oxide of cobalt of a greenish colour were separated. The precipitate, when dried in a gentle heat, weighed, without reckoning the small quantity separated during the evaporation, about as much as the oxide of cobalt employed, and had a violet colour. The saline mass, when again dissolved and filtered, was of a pale green colour, had a sharp metallic taste, and exhibited the following phænomena:

1st, It gave a red colour to litmus paper. 2d, It contained ammonia, nitrous acid, and a little cobalt; for when a little of it was decomposed in a red heat and evaporated to dryness, which was accompanied with crackling and inflammation, nothing remained but two or three grains of black oxide of cobalt, without a trace of acid. 3d, It produced no turbid appearance in acetite of lead: 4th, Nor in nitrate of silver. 5th, It rendered ammoniate of copper exceedingly turbid; but by the addition of more solution it was redissolved and became perfectly clear; which proves that the precipitate had been effected by the free acid of the combination. 6th, It communicated scarcely any turbid appearance to sulphate of copper: 7th, Nor did it disturb in any manner nitrate of mercury prepared without heat. 8th, It produced no change in a concentrated solution of muriate of barytes.

From this experiment, and the phænomena it exhibited, it appears proved beyond a doubt, 1st, That by the processes described all the muriatic acid had been driven off: 2d, That no more arsenical acid was present: and, 3d, That no cobaltic acid can be formed by this process.

Now,

Now, as the result of these experiments is, that cobalt cannot be converted into acid by the most powerful and most active means employed for changing into acids those metals susceptible of acidification, and as it is not improbable that nature may produce some circumstances favourable to the formation of cobaltic acid, though there is not the least reason to suspect that this can be the case in the preparation of the gray oxide of cobalt, nothing remains but to admit that the cobaltic acid of Brugnatelli was an union of arsenical acid with other substances; and this conjecture is the less hazarded, as it is well known that all oxide of cobalt contains more or less arsenic, and in all probability in the state of acid. It now remains to show, if possible, that this union of arsenical acid is capable of producing the phænomena which Brugnatelli observed in regard to his supposed acid of cobalt. This, in my opinion, will be best accomplished by the phænomena which occurred in the following experiments.

Experiment IX.

Four hundred parts of pure liquid ammonia were poured over fifty grains of arseniate of cobalt obtained by precipitation, and digested two hours, during which the mixture sometimes was made to boil. After the liquor, which was of a red colour inclining to blue, was separated by filtration, the same quantity of pure liquid ammonia was poured over the undissolved residuum, and the process repeated. The colour of the liquor thus obtained was not so blue. The residuum had lost about two-thirds in weight, and had become blueish red; whereas the arseniate of cobalt has a pale rose colour. The two fluids obtained were evaporated to a dram, during which operation the greater part of the dissolved oxide of cobalt was separated of a grayish blue colour. The filtered liquor was of a cochineal red, and exhibited the following phænomena:

1st, A little of it being evaporated to dryness in a porcelain dish, suffered ammonia to escape, and also deposited a little grayish green oxide of cobalt. The residuum, diluted with distilled water and filtered, had scarcely a reddish colour, as Brugnatelli observed in a specimen of his cobaltic acid, and had a sharp acid taste, a property which he ascribes in general to his cobaltic acid. It still contained a little ammonia, and some traces of cobalt.

2d, It gave a perceptible red colour to litmus paper, but no acid taste was perceived in it.

3d, It precipitated lime water, without being redissolved, by

by the addition of more fluid; whereas the precipitate obtained (1) by further heating the obtained fluid, was immediately redissolved by the addition of more fluid.

4th, Muriate of barytes in a concentrated state was also precipitated by it, as well as by arseniate of ammonia.

5th, Nitrate of silver was precipitated by it of a brownish colour: by shaking it with a little muriate of potash, muriate of soda, or muriate of ammonia, the precipitate immediately became white.

6th, Acetite of lead was precipitated by it white, and immediately redissolved by a very small quantity of nitrous acid.

7th, Sulphate of copper was precipitated of a bright green colour.

8th, Ammoniate of copper was precipitated in the same manner, but in greater abundance.

9th, Nitrate of mercury was precipitated by this fluid of a bright straw yellow colour; by more acid fluid (1) the case was the same, and the precipitate produced arseniate of ammonia.

As all these properties of cobaltic arseniate of ammonia correspond with those of the cobaltic acid of Brugnatelli, those of (5) excepted, no other conclusion can be made than that Brugnatelli's acid was the same combination, more or less altered by the treatment; for according to his assertion he obtained, by moderate heat in the sun, the cobaltic acid solution of a red colour, whereas when evaporated slowly by heat it was almost colourless. The production of this union, by Brugnatelli's treatment of zaffer with ammonia, can easily be explained: zaffer contains arsenic, and in all probability arseniate of cobalt. By digestion with ammonia this is in part decomposed; and as most of the cobalt is separated, there arises a triple combination of arsenical acid, ammonia, and more or less cobalt, which in a stronger heat suffers a part of the ammonia and cobalt to be disengaged, and then contains more or less free acid. The difference in the property (5) of my combination and the cobaltic acid of Brugnatelli can be easily explained, if it be admitted that Brugnatelli's ammonia contained a great deal of muriatic acid; which is very possible; for in this case the brown arseniate of silver produced by the arsenical acid of the combination in question must have been immediately redecomposed, as the muriatic acid, in consequence of its greater affinity for the silver, united itself to produce muriate of silver in a white form, and then gave rise to the precipitate of Brugnatelli.

Brugnatelli,

Brugnatelli himself suspected that his cobaltic acid was arsenical acid; but he was so deceived by certain considerations that he paid no further attention to this suspicion, and neglected to verify it by experiments: on the contrary, he was convinced of the reality of his cobaltic acid on the following grounds:

1st, The arsenical acid does not precipitate silver from its solution, but the cobaltic acid does.

2d, The arsenical acid decomposes lime water, and the precipitate is redissolved by the addition of new arsenical acid or lime water; the cobaltic acid decomposes lime water, and the precipitate produced dissolves neither in a new quantity of cobaltic acid nor in a new addition of lime water.

3d, Neither acetite of lead nor muriate of barytes is decomposed by the arsenical acid; on the other hand, both these salts are immediately decomposed by the cobaltic acid.

4th, The arsenical acid dissolves very well in alcohol: on the other hand, liquid cobaltic acid, when united with pure alcohol, is immediately precipitated in a solid form.

What weight these four arguments have in regard to the existence of the cobaltic acid, I shall now examine.

In regard to the first, the assertion of Brugnatelli is directly contrary to experience. The arsenical acid certainly precipitates silver from a solution of arsenical acid, and of a brown colour; but with a small quantity of this acid and a large quantity of muriatic acid, white. This appears from what has been already said, and has been proved by my own experience. Against the justness of the assertion which Brugnatelli gives as the second ground for the existence of the cobaltic acid, nothing, so far as the question relates to pure arsenical acid, can be objected; but that the union of arsenical acid, ammonia, and cobalt, produces with lime water the same phænomena as Brugnatelli observed in regard to his cobaltic acid,—that is to say, of precipitating lime water without dissolving the precipitate produced by the addition of more of the precipitating matter,—has been already seen in the ninth experiment (3). Hence it follows that the second ground is equally unsatisfactory and inconclusive.

The ground which Brugnatelli assumes as the third proof of his cobaltic acid, is in part incorrect, and contrary to all experience: every chemist knows that acetate of lead is very easily decomposed; by which means a very abundant precipitate of arseniate of lead is produced, which is exceedingly difficult of solution on a new addition of arsenical acid. It

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is however true, that muriate of barytes is not rendered turbid by arsenical acid: but arseniate of ammonia forms with a concentrated solution of muriate of barytes as abundant a white precipitate as this triple combination, which, when the solution of the mixed salts is very much diluted, takes place sparingly, and in shining leaves: but the precipitate, by the addition of free arsenical acid, again disappears. What opinion ought therefore to be formed of this third ground of argument may readily be seen.

In regard to the fourth, I shall leave it entirely to the judgment of the reader. I shall however observe, that we may conclude, without much danger of erring, that the four circumstances here adduced by Brugnatelli as proofs of the existence of his cobaltic acid, are not conclusive. They are not contrary to the principle here established by experience, that the supposed cobaltic acid is a triple combination of arsenical acid, ammonia, and cobalt, in which the first acts the most distinguished part. In consequence of the falsity of the experiments from which they are deduced, they throw an unfavourable light on the accuracy of Brugnatelli's process, and give us some clue to guide us, in regard to the opinion which ought to be formed of the other assertions of Brugnatelli, and the phænomena he observed in regard to the cobaltic acid.

From the experiments, considerations, and deductions, here mentioned, we have the following results:

I. Cobalt cannot be converted into an acid when treated with ever so much nitric acid, and often repeating the process.

II. Nor can this be effected by means of muriatic acid and nitrous acid, according to the process of Scheele.

III. The supposed cobaltic acid of Brugnatelli is in all probability nothing else than unmasked arsenical acid, an union of this with ammonia, and a little oxide of cobalt. At any rate, this union produces the phænomena which Brugnatelli considered as characteristic of his cobaltic acid.

IV. Cobalt free from arsenic, or the oxide of it, will not, by treatment with nitric acid and ammonia, produce the phænomena exhibited by the cobaltic acid of Brugnatelli, and which can also be exhibited by our union of arsenical acid with cobalt.

V. These experiments, and the circumstances attending them, prove how necessary it is to examine every new discovery before it is admitted as truth; unless people wish to be deceived, and to be under the necessity of retracting what they have before asserted.

XV. Me-

XV. *Memorial of Mr.* E. G. J. Crookeens *respecting the Distillation of Spirits, &c. in Holland. (Translated from the French.)* *

In order to answer the questions relative to the purity and goodness of the spirit distilled from grain, I shall chiefly confine myself to that which is distilled in Holland, and so much esteemed in this country on account of its flavour as well as of its purity and salubrity; because the nature of this spirit, or geneva, and the method of distilling it, from the first beginning to the last stage of rectification, is better understood by me than the spirit distilled in this country, and the manner of distilling it. If you consider the humidity of the air in Holland, and the influence which this unhealthy air must naturally possess upon the health of the inhabitants, and that not only all the physicians, but also the people at large, are convinced that the spirit drawn from grain, or geneva, as it is there distilled, if drunk with moderation, is an universal preservative against the infirmities and epidemical diseases which this damp air must naturally produce, it cannot be a matter of surprise that the use of geneva is so universal throughout Holland, and that the Dutch nation has carried the art of distilling it to a degree of perfection which it has not yet been possible to attain in any other country. To form a judgment on the beneficial nature of this spirit, I shall only quote this one fact, averred by daily example, and which has certainly not escaped the notice of English travellers who have traversed Holland, or resided there some time with a spirit of observation, viz. that numbers of persons are found much advanced in years who since their youth have made considerable debauches in this spirit, while all those who commit similar excesses in foreign spirits succumb and perish in the bloom of life; and this observation leads me naturally to this question, Wherein does that beneficial virtue of the Dutch geneva consist, which it enjoys in preference to all other spirits? The answer to this question must be found in the sort of grain, in the good quality of each sort, in the manner of proceeding and drawing from it a spirit which is pure, and unmixed with any heterogeneous matter which might impair its natural goodness. An explanation of these points will contain, I think, the answer to the principal

* From the Parliamentary Report respecting the Distilleries in Scotland.

question

question respecting the manner of improving and meliorating the distilleries in this country.

I am perfectly aware that, treating on these particulars, I shall not be able to explain myself in a language which is not my native speech, with that purity and precision which the importance of the subject requires; but I shall endeavour to supply this deficiency by that veracity and frankness which may naturally be expected from a man who is not in the least connected with the distillers in this country, nor anywise personally interested in concealing or altering facts, and who in this business looks out for no other reward but the pleasure and satisfaction of being able to contribute his mite to the public welfare, and to the preservation of the health of so many millions of people, who may suffer either from the ignorance or avarice of the distillers,—reserving to myself only some peculiar manipulations, which have no influence on the public welfare, and which can merely serve the private purpose of distillers, who use and put them in practice.

On entering upon this subject I shall have no occasion to enlarge on the quality of the grain, it being universally known, that in order to produce a spirit which is pure, and of a pleasant flavour, grain must be used which is pure, and not spoiled by wet either in the field or the granaries. I shall therefore confine my observations on the species of grain, and observe in this respect, that the Dutch distillers are perfectly acquainted with the manner of drawing spirits from the malt of barley, as well as from unmalted barley with a portion of malt added to it, in the proportion of a third or fourth part; and there are several petty distillers in that country who still make use of that grain on account of its low price; and in general the spirit drawn from barley is of a very pure and vinous nature, provided always that the operation be conducted in that slow manner which shall be developed in the sequel: nor is it less true, that all great distillers in Holland are convinced that malt yields not only a purer spirit, but also a greater quantity than raw barley mixed with malt, in the before-mentioned proportion, contrary to the general opinion of the distillers in this country; and my own experience has confirmed me in the above opinion, if the malt be perfectly well made, for a very evident reason. The artificial vegetation which the grain undergoes disengages the saccharine matter, and renders it more proper to be extracted by the water; nay, it augments the saccharine matter contained in the grain. To be convinced

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of the truth of this remark, we have only to examine the malt from time to time during the operation, and we shall find that this matter develops itself more and more as the grain grows longer; yet this vegetation should be stopped as soon as this matter is disengaged from the length of the grain, otherwise the saccharine part will be lost; and if it be stopped too soon, when this matter has only disengaged itself from half the length of the grain, as is done by several brewers in Holland, all the saccharine matter contained in the grain not being disengaged, it cannot be so easily dissolved in the water. I am convinced by several experiments, which I have made myself on several sorts of malt, and in different degrees of perfection, that about a fourth part more spirits is obtained from malt, which is perfectly well made, than from that in which the vegetation has been checked too soon, or carried to excess. The manner of drying it is also an article of equal importance; and in general, malt dried too quick, and by an unequal heat, yields not as much spirit, nor a spirit of as pleasant a taste, as malt dried in an equal and slow manner. If it be considered that the saccharine matter of the grain produces alone and exclusively the spirit, it will be easily conceived that malt of barley must yield more spirit, and of a more pleasant taste, in proportion as the saccharine matter is more developed in the malt, and rendered more proper to be extracted and dissolved by water than in unmalted or raw grain, where this matter is united and combined with the other particles of the grain; and if some distillers in this country are of opinion that raw barley mixed with a certain quantity of malt produces somewhat more spirit, they must necessarily have made their experiments with malt which had not attained the last degree of perfection, and they must not understand as well the art of making malt as the brewers in this country, who have carried it to the highest degree of perfection. I rather incline to think that the distillers in this country prefer raw grain for the same reason it is preferred in Holland, namely, because it neither costs so much trouble nor expense, and that the result depends not on as many little circumstances and precautions.

In Holland but very seldom use is made of barley, notwithstanding the purity of the spirit which it yields, as it has been found out that barley yields but little spirit compared with other grain: for this reason other species of grain have been substituted in its place, which yield a more considerable profit, while at the same time the spirit they

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give is by no means inferior, from the precautions attended to in the operation.

Wheat mixed with a portion of barley malt, in the above-mentioned proportion, yields more spirit than barley, and of a vinosity and fineness of taste which exceed all belief; and the distillers in Holland, who wish to produce a very fine geneva, make use of wheat, and sell this spirit to private persons, who desire to have it, at double the price of common geneva; and if the fermentation and distillation be conducted with prudence, a spirit may be drawn from it which equals the spirit of wine in vinosity and flavour. I have known a distiller in Rotterdam who sold his spirit drawn from wheat for true French spirit of wine; and in order to give it this flavour he made the grain ferment with the dried lees of wine, which he procured from France, instead of barm; the lees of wine having this advantage, that they procure a slow fermentation, and, as they contain a considerable quantity of essential oil of wine, they communicate to the spirit the flavour of the wine from which they are taken. In Westphalia, and throughout the whole circle of Lower Saxony, no spirit of wine is to be found anyways passable, although the distillers follow the process observed in Holland in regard to the composition, without acting upon the principles of the Dutch distillers with respect to the fermentation and distillation, excepting the bishopric of Hildersheim and its environs, where the distillers make use only of raw wheat mixed with a small portion of malt; and this proves the superiority of wheat above all other species of grain.

Notwithstanding all these advantages, wheat is not made use of in Holland for common or general use, as experience has proved that rye, which in ordinary times is much cheaper than wheat, gives nearly a third more spirit than wheat, and that by the way of proceeding they have attained the art of drawing from it a vinous and pleasant spirit, and in point of salubrity by no means inferior to that drawn from barley or wheat, nay, perhaps superior in this respect to the two others. Previously to my entering upon a minute account of the distillation made use of and practised in Holland, I ought to observe, that it must not be supposed that all the distillers scattered through that country are able to make good spirits. You find, on the contrary, in many places very bad geneva; it is only the great distillers in Schiedam, Welsep, Rotterdam, and in general the distillers in the province of Gueldres, who are capable

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of delivering the spirit, which is so much sought after and valued in foreign countries, while petty distillers, though they follow the same method, but not to the same perfection, from want of a knowledge of the first principles, and of a good theory of the art of distillation, fail in their object; and it is for this reason that the servants and workmen who were procured in this country from the distilleries in Holland, have never been able to succeed in producing a spirit of the same good quality as their antient masters made in Holland; and this is exactly as if a machine employed in manufactories were given to a man to make a stuff the properties of which he does not know. The art of distillation is a branch of chemistry, and subject to the principles and unvariable laws of that science, and a person destitute of a knowledge of the first principles of that science will never attain to the desired degree of perfection in the distillation of spirits from corn or grain. In Holland are also found unprincipled distillers, who, making use of spoiled grain, have recourse to the pernicious additions to cover the bad taste and flavour of their spirit; but fortunately the palate of the people is so accustomed to a pure spirit, that this pernicious geneva cannot be sold in the interior, but is for the most part exported to the two Indies, Africa, and other countries.

Commonly three sorts of spirit are made: one which requires to be rectified over juniper berries for the use of the interior, which is in some degree weaker than that exported for England, because in Holland it is not usual to mix it with water, but to drink it pure; another for being exported to England, also rectified over a small quantity of juniper berries, but some degree stronger; and a third sort, rectified to the same degree of strength, but without the addition of juniper berries, for exportation to America, because the North Americans do not like that flavour, but prefer the spirit quite pure, without any addition which may give a peculiar taste.

There are two principal processes:—The major part of the distillers take a quantity of flour of rye, ground rather grossly, mixed with a third or fourth part of barley malt, proportionate to the size of the tub in which the vinous fermentation is to be effected. They begin by mixing it with cold water; this mixture is much stirred with the hand to prevent the flour from gathering into lumps, and that it may be evenly divided. When this point is attained, water is added to the mass, which water must have been heated to the degree of the warmth of human blood: the whole

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must be well stirred, in order to divide the grain in an even manner; after which the ferment is mixed with this wash, after it has been previously well diluted with a little of the liquid. Great attention should be paid to the tub being kept in a moderate degree of warmth, fit for the intended fermentation, by giving the air some access to the liquid, and by preventing the rays of the sun from falling on the tub in summer, and by procuring a current of fresh air for the laboratory: the fermentation generally begins in this case six hours after; should it be sooner, it is judged that the fermentation will be too strong, and means are employed to check it: if it does not commence soon enough, proper means are made use of to accelerate it: if the fermentation be well conducted, it generally terminates the third day, and the liquor grows very transparent, and assumes an acrid taste, hot, and biting on the tongue. When it has attained this point, the wort is well stirred, and the mash with all the corn is put into the caldron; and hereupon they proceed to the first distillation, which is conducted very slowly. Great attention should be paid, that the mash be taken exactly at that time before the acetous fermentation, which destroys the spirit, can begin. The slowness of the first distillation is a point of the utmost importance; because, if you proceed rapidly, the essential oil goes over with the spirit, and mixes with it so intimately, giving it at the same time an unpleasant taste of corn, that it is impossible to separate it from the spirit, or to destroy this taste, but by pernicious additions hurtful to health: thus, then, the success in obtaining a good spirit chiefly depends on the first distillation. Hereupon the liquor is rectified over juniper berries once or twice, according to the sort of spirit which it is intended to produce. For common use one rectification is sufficient; because, if the above precaution be attended to, the spirit is sufficiently mild to be drunk by the people, though not so fine, pleasant, and delicate, as that which has undergone several rectifications; and the product of these multiplied rectifications is called double geneva, and paid for accordingly. Some distillers mix their juniper berries immediately with their wort, and cause the whole to ferment together: but in this case they can only draw from it a spirit for the use of the interior, or for exportation to England; for this reason they are generally only made use of at the rectification. In the beforementioned case, and method of operating, I would however recommend the addition thereof previous to the fermentation,

tion, because the juniper berries by their aromatic virtues augment the spirit a little if the fermentation be conducted in a proper manner, as will be seen in the sequel.

The second method observed by the best distillers is as follows:—You take the malt and rye in the given proportion, and further some warm water, heated to a certain degree of warmth; you mix the corn, grossly ground, with this water, stirring and working it well, until the whole be well mixed and evenly divided; then let the wash rest some time, until the meal has settled at the bottom; hereupon let the liquid matter flow into the fermenting tub, and recommence the same operation with another quantity of water poured upon the same corn, and repeat these operations until you are convinced that the water thus drawn from the corn at different times has dissolved the whole saccharine matter contained in the meal; put this water into the fermenting tub, and as soon as the warmth is diminished somewhat under the temperature of the blood, add the ferment. The fermentation does not begin so soon as in the first method, but is more regular and slow. Other distillers, who observe the same method, pour all the water which they intend to make use of, in order to have a well diluted wort, and of an equal degree of heat, at once in a tub, and put their meal gently and slowly into this whole mass of water, while one or two persons are quickly stirring the mixture with sticks made expressly for that purpose, in order evenly to divide the meal, and to prevent it from gathering into lumps. When the whole is well mixed they proceed, as mentioned in the preceding article, by drawing off the liquid from the grosser matter, &c. &c.

This method is not entirely to be rejected, because the water has thus a more free access to every part of the corn, and for this reason can more easily extract the saccharine matter. After the fermentation is finished, and the liquid has become very transparent, and assumed the hot and biting taste, you proceed to the aforementioned slow distillation.

In all these cases the water for making the wort must be more heated in winter than in summer; and when the weather is uncommonly hot, you should cool the liquid with cold water, and at the same time add to it a little fresh flour; and by this means you obtain a slow and almost imperceptible vinous fermentation, which is a very important point in regard to the quality as well as the quantity of spirit.

[To be continued.]

XVI. *On the Cure of the Gout.* *By* A. Stenhouse, *M.D. Edinburgh* *.

I have heretofore given some communications on the effects of ginger in the gout; and, although I have received much relief in the painful stage of that disorder, by the daily use of it for these three years past, yet the debility that followed was not less tedious: so that I continued my pursuit of something more efficacious, which I am hopeful I have at last found, and which I consider it to be a duty to promulgate. Much have I thought for these eighteen years, and many an unintelligible page have I read upon this subject: but to come to the present question, since I am not writing a book:—In the month of April last, a publication was put into my hand, which had escaped my notice, by a judicious acquaintance, to whom I am much obliged, entitled 'Facts and Observations respecting the Air-pump Vapour-bath † in Gout, Rheumatism, Palsy, and other Disorders; by Ralph Blegborough, M.D., Member of the Royal College of Surgeons, London;' which apparatus, if it has all the effects ascribed to it, should be in every hospital and neighbourhood. I was so much pleased with the successful operation of this apparatus, because it confirmed an opinion I have long entertained of the immediate cause of a paroxysm of the gout (for of the gout I am only speaking) that I was determined to try the experiment on myself the first opportunity, though on a more simple scale: my opinion will be elucidated by the following remarks and experiments:

The immediate cause of all acute pain I take to be either irritation or obstruction: the latter is surely the immediate cause of a gouty paroxysm. To trace causes to their elements is but an uncertain pursuit, and cannot be attempted here. That this obstruction takes place in the minute branches of the arteries, I hold to be true; nor do

* From the *Edinburgh Courant* of January 9, 1804.

† For a description of this apparatus see a printed letter of Dr. Blegborough, dated February 10, 1802; also the Philosophical Magazine, vol. xiv. p. 289. We cannot here avoid noticing a late plagiarism of this invention. A French paper, *Le Clef du Cabinet*, of June 5, 1803, informs the Parisians, that a M. Jaques Boyol, a physician at Nice, among other useful medical machines, has invented different pumps for curing gout, rheumatism, palsy, &c. by administering baths of air and vapour. The article concludes with stating, that Mr. Nath. Green, the English consul at Nice, had offered the *modest* inventor 30,000 guineas to carry his discovery to London!!!

I see

I see any phænomenon in a fit of the gout, but what may be accounted for by this hypothesis. It will be easy to see that for the present I deny the existence of gouty matter; nor do I consider the earthy concretions formed in the joints after repeated severe attacks to be a proof of this, since the same phænomenon may be produced from the blood out of the body by a similar process. It is remarkable that, though much has been written on this subject, so little has been attempted, either to prevent the generating this disease, or mitigating the violence of its paroxysms. The reason of this I take to have been a supposition that there was something deleterious in the obstructed matter, and that it was unsafe either to prevent the fit, or tamper with the parts affected: of this prejudice I have had my share until within these three years. There is a prevalent opinion I know, with those unacquainted with the laws of the circulation of the blood, that there are applications, very improperly called repellents, which may drive back the gouty matter; but I tell my gouty readers, there is no operation can take place in the animal system in this sense: in fine, there can be no repellents nor discutients where there are no absorbents: but my readers must be cautious how they counteract the intentions of nature, or, if they must use the word, they must beware that by improper applications they do not repel the disposition of the system to produce a paroxysm, and thereby send it to some more vital part; which happened to myself, the first symptom I had of this disease.

I come now to describe my practice upon myself; I have already said I took the hint from the air-pump vapour-bath eight or nine months ago. The end of September last I was attacked in my right hand, but being in the country I could not put my intentions in practice until I came home; by this time the fit had acquired its last stage both in pain and swelling. I then got a common tureen half full of boiling water; I laid my hand across, and covered all over with some folds of flannel; but presently the steam was so hot, that I was obliged to reduce the heat of the water so as to be able to bear the steam. In a few minutes the pain abated, and in about 25 minutes I was perfectly free from pain; and as the steam became so cold as to be no longer useful, I dried my hand and wrapped it up in flannel; and, had it not been for the swelling, I could have used it as well as if nothing had happened. About this time my right foot began to give me some symptoms of an attack; I allowed it to proceed for about 24 hours, or until

I was convinced it was to be a real fit. I then got a pail with two handles, and from the handles I suspended a towel to rest my heel upon; I then filled the pail with boiling water, so full as not to touch my heel, and covered it over with several folds of flannel for about half an hour, as in the first experiment; I dried my foot, and wrapped it up in flannel: I was perfectly free from pain, and walked about the room as usual. I repeated this immersion five or six times this day and the following, since when I have had no complaint in my foot; but, as I had only immersed my hand once in steam, in two days the pain returned, as if the obstruction had not been perfectly removed. I had recourse to the steam again, which I repeated two or three times. I have waited thus long to give a fair trial to its effects. I am still alive, and have been in good health ever since, though at the border of seventy.

May I not fairly say that here are two experiments, and, what is more, at different stages of the paroxysms, which have been successful in removing the immediate cause, which I consider to be obstruction only, by the relaxing quality of the steam, or, what is the same thing, diminishing the pressure of the common atmosphere? Finally, I shall continue the ginger daily, and repeat the vapour-bath when necessary; and if either stomach or bowels, or other viscera, shall be attacked, I shall immerse my whole body in a hogshead of steam. To prevent the frequent return of the paroxysms I live abstemiously, being certain that, in my case, the habit of body between repletion and inanition will conduce thereto; and such a state will be the most likely to prevent or mitigate diseases of any kind. If what has been said and done shall be thought erroneous, I shall kiss the rod of conviction.

A. Stenhouse, M.D.

XVII. *On the Use of Steamed Potatoes as a Substitute for Hay to Cattle**.

The silver medal of the Society for the Encouragement of Arts, Manufactures, and Commerce, was this session voted to John Christian Curwen, esq. M.P., of Workington Hall, in Cumberland, for his extensive experiments on feeding cattle with steamed potatoes; from whom the fol-

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, vol. xxi.

lowing

lowing accounts and certificates were received, and to which engravings and descriptions are annexed:

SIR,

In a letter, which I had the pleasure of addressing to you some time ago, I took the liberty of hinting at an experiment I was making, in giving steamed potatoes as a substitute in a great measure for hay.

I was then wholly unacquainted with its having been tried. It was from my friend the bishop of Landaff I first learnt that the Board of Agriculture had made a report upon it. As I do not find that was carried to any great extent, nor given in the way I have done, I shall, with much deference to the Society of Arts, &c. offer what has occurred to me, together with the plan I have adopted for steaming and washing. Having nothing of the kind to assist me in my beginning, I found great difficulty and much time consumed, which I trust this will remedy to those who may be inclined to make the experiment.

My respectable friend and neighbour the bishop of Landaff took the trouble of examining the process, and inquiring into every thing relating to it, and has certified the complete success of the plan, and his approbation of the apparatus. It was in consequence of the alarming failure in the hay crop of the year 1801 that I found myself called upon to take some steps to prevent the serious consequences which were likely to result from it. The importations of hay from Ireland in August were from 9d. to 11d. per stone of 14 pounds. In this situation it fortunately occurred to me, that I had for many years given a proportion of steamed potatoes, mixed with the other food, to my hounds, and found it to answer extremely well. If hounds could stand their work with this feed, I could scarcely admit a doubt of its being a hard as well as nutritious food. Under this impression I began my steaming in October 1801, and continued it till late in May. The prejudices I had to encounter were such as would have defeated the plan, had I not followed it up for some months with constant and unremitting attention; and whoever attempts it, will have difficulties to contend with that require particular attention to overcome. In no one instance did it fail, and my horses were never in such spirit and condition. In October last I recommenced my operations, and am able to steam from 160 to 200 stone, of fourteen pounds each, per day: I have fed upwards of eighty horses constantly both seasons; and this year I have extended the feed to my

milch cows, taking away all hay and only giving a little straw. Each horse has a stone and half of potatoes, or twenty-one pounds, estimated at 3d. per stone, 4½d.; steaming, a halfpenny; ten pounds of bruised corn, 6d.; five pounds of hay, 2d.; two pounds of cut straw to mix with the corn, a halfpenny; making on the whole 13½d. per day. Each tub of potatoes, containing eleven stone, has one of cut straw mixed up with it; it is given warm, and a horse will eat a stone in less than half an hour, whilst between six and seven would be required to eat a stone of hay. The time gained for rest contributes greatly, I have no doubt, to promote the health and condition of the horses.

The facility with which potatoes can be transported from place to place, is much in their favour, and being without damage, to which hay is liable, is a further object. The individual gain will be found great where ground is highly rated and not easily procured, as will be commonly the case where horses are most wanted. In a national point of view it may be important, should the population of the country advance as rapidly as it has for some years past. The potatoe crop is produced from ground which would otherwise be under fallow; and when proper care is taken, the wheat after potatoes is equal, if not superior, to that from fallowed ground. The year previous to my adopting my present method, I sunk the rent of my farm, valued at a thousand pounds (about 700 acres), and seven hundred pounds besides. In the last year I cleared, receiving the same prices for my work, 2189l. The only difference I can point out is in the price of oats; this might deduct 300l. I had forty acres last year under potatoes: the wetness of the ground, and the very unfavourable season, made my crop a bad one. I shall have this year sixty. I have found no difficulty in importing from Scotland and Ireland, at 3d. and 3½d. per stone. The quantity being more than I required, I have sold to the poor at reduced prices at 3d. whilst the markets were from 5d. to 6d. I had 300 acres under hay, and never sufficient: I expect that 150 now will be more than sufficient for all my wants. The value of hay was heretofore in proportion to my necessity: having no longer occasion for any, the price will fall to the neighbourhood. Indeed it has, as I might purchase at 6d. per stone what was seldom or ever under 9d., and more frequently a shilling. I have every pound of hay weighed, so as to prevent all waste; and, though this is some trouble and expense, I have reason to believe it is amply repaid by the œconomy it enforces.

5 I beg

I beg pardon for the unreasonable length of this letter. Without a considerable degree of enthusiasm, I should never have got through with my undertaking; and the society will, I hope, excuse me if I have attached more importance to the matter than it deserves. If any further information should be wanted, I shall be happy to give it.

With great respect,
I have the honour to be, sir,
Your obedient servant,
J. C. Curwen.

P. S. I make no difference in the feed of a cart-horse, or one of my carriage horses; the allowance is the same. The coals for steaming 160 stone of potatoes, I have found to be two Winchester bushels and a quarter, or 137 lb. of coal.

	£.	s.	d.
One labourer also is sufficient to steam, wash, &c. 160 stone - - - - - -	0	1	8
Two Winchester bushels and a quarter of coals, at 3d. each bushel - - - -	0	0	7
	0	2	3
The cost is therefore under a farthing per stone, leaving a residue of 13d. per day, which in six months would produce - - -	9	15	0
The cost of the apparatus, washer - -	12	12	0
Four tubs, at 2l. 2s. each - - -	8	8	0
Boiler - - - - - - -	5	5	0
Platform for the tubs - - - -	10	10	0
Pump - - - - - - -	5	5	0
Building - - - - - -	60	0	0
Belle Isle, March 6, 1803.	102	0	0

To Mr. Charles Taylor.

SIR,

In addition to what I have had the pleasure of communicating to you on the subject of potatoes, I wish to add a few observations, to guard such as may be inclined to make the experiment of feeding with them, against the pernicious effects of the liquor which distils from the potatoe. The first attempt I made to give potatoes to hounds, was

fifteen years ago: they were boiled with their other food; but I was soon obliged to desist from it, the hounds being very violently purged and affected by it: from this trial I was satisfied that the potatoe liquor contained a very poisonous quality, which must be highly pernicious. Indeed, I have no doubt, if any animal was suffered to drink the water which comes from the potatoe, it would be destroyed by it. It is upon this account I adopted the leaden cistern upon which the tub rests, and into which the steam is introduced. Though I am satisfied there is a great loss of steam by it, and an increased expenditure of fuel, yet to keep clear of the potatoe liquor mixing with the potatoes, is of the first importance. As a remedy against the loss of steam, I should advise to lengthen the steam-pipe in the cistern, so as to throw the steam to the centre of the tub, and to have a hole cut, and covered with a leaden cap, with holes for the steam to pass through; by which means the condensation will fall by the sides of the tub, and much steam be saved. The potatoes are made much drier by suffering them to stand a few minutes in the tub after the steam is taken from them.

I had so little assistance from any thing previously done in steaming, that the first season it required five men to do the work which one man can now accomplish with ease. It took two persons to wash them, which they did in a very incomplete manner; two to steam and bruise, and one man and a horse to furnish water. The washer will be found to answer the purpose admirably well; and when the saving of water is an object, its value will be increased. Several private families have adopted them upon a small scale, and found great convenience from it. I believe the method I have adopted of mixing a portion of cut straw (from a tenth to an eleventh part) is highly advantageous: first, as it prevents the food passing too quickly; and, secondly, as it keeps the mouths of the horses from being clogged with the potatoes. Should doubts still remain as to the performance and health of the horses thus fed, I am ready to afford unquestionable proof from the persons who have the care of them. I shall always be ready to answer any questions, or to afford any further information in my power.

From what I have previously stated, the advantages I have already reaped from this method will be apparent; and I cannot but sincerely wish, both for the advantage of the public and individuals, that through the medium of your most

most useful and respectable society it may come recommended to them; which cannot fail of having considerable effect. I have the honour to be, sir,

Your obedient servant,

J. C. CURWEN.

London,
March 12, 1803.

To Mr. Charles Taylor.

P. S. When the potatoes are sufficiently done, being of a heat equal to the steam, the distillation ceases, and the steam comes through the cock. The condensed water from the steam formed during the operation is allowed to run off, affording a constant stream.

The above statements were confirmed by certificates from the bishop of Landaff, and Arthur Young, esq.

Reference to the Engraving of Mr. J. C. Curwen's Method of Steaming Potatoes for the Use of Cattle. Explanation of Fig. I, or the Ground Plan. (Plate II.)

A, the well from whence the water is furnished to wash the potatoes.

B, the spout which conducts the said water to the reservoir, where the potatoes are washed.

C, the frame of the potatoe washer, and reservoir of water.

D, a hollow wooden cylinder or barrel, hooped with iron, and perforated with oblong holes: it has a door at D, to allow the potatoes to be put in or taken out; it is of such a size, that eleven stone of potatoes will fill about two-thirds of it, which quantity it will wash in two minutes; it may be used six times, or wash sixty-six stone of potatoes, before the water in the reservoir be changed. When the potatoes are taken out of the water, either pump upon them, or throw a pail of water over them, and let it drain through them.

E, the winch or handle, which works the washer by means of a small pinion F, working in a larger toothed wheel G, occasioning one revolution of the washer from two of the handle, as shown more fully in the subsequent plate.

H, the conduit, through which the dirty water is conveyed away from the reservoir.

I, the circle in which the crane K moves from its centre at K, and in tracing which circle the washing cylinder, when lifted from the water, is conveyed to the potatoe back or place of deposit L, which is raised from the floor the height of one of the tubs, or will meet one of them at the other

other circle M, so as that the other crane N may convey the tub from thence to one of the lead vessels O, on which the potatoes are steamed.

P, the brick-work of the water boiler in which the steam is formed.

Q, the grate on which the fire is made.

R, the leaden steam pipe, one and a half inch diameter, a branch from which enters each of the vessels OOOO, made of sheet lead, and on which vessels the tubs containing the potatoes stand whilst steaming.

SSSS, the cocks which let out the water condensed from the steam, and impregnated with the juice of the potatoe.

T, the conduit which conveys away the water.

V, the frame-work or stillage, on which the leaden vessels stand, about ten inches higher than the floor.

UU, the stone troughs, in which the potatoes are bruised after being steamed, and before they are given to the cattle.

Explanation of Fig. II.

C, the back or reservoir of water, for cleansing the potatoes.

D, the wooden cylinder or barrel, which, by turning the iron axis extending through it, washes the potatoes contained in the cylinder; it is here shown in the state ready to be raised, by the crane and jack K, from the dirty water; it can be disengaged from the toothed wheel G, by a jointed notch between the head stocks at W.

E, the winch handle.

F, the smaller pinion.

G, the larger pinion on a line with the axis of the cylinder.

X, a water-back or cistern above the boiler, supplied from the pump Y, by the spout Z.

N, a crane and jack, by means of which the potatoes, when washed, are conveyed to the steam vessels.

No. 1 1 1, three of the wooden steam tubs, with perforated bottoms, placed on the leaden steam vessels or cisterns OOO.

2 2, the boiler for the water formed of two iron pans, screwed together by two flanges; each pan is in capacity forty gallons.

R, the leaden pipe, which conducts the steam from the boiler to the steam vessels.

OOOO, the four leaden steam vessels, each twelve inches diameter, and nine inches deep; one of them is shown separate from its wooden tub.

3, a

3, a cock which conveys the water by a pipe from the reservoir to nearly the bottom of the boiler.

4, a cock which stops the steam when the potatoe tubs are taken off.

5, a safety valve fixed upon the top of the boiler, loaded with a weight of about four pounds to a square inch.

6, a cock fixed in the side of the boiler to ascertain when it contains a proper quantity of water.

7, one of the potatoe tubs detached from its lead vessel: it is two feet high, twenty inches wide at the top and seventeen inches at the bottom; it will hold eleven stone of potatoes. The boiler will steam sufficiently the four tubs of potatoes in fifteen or twenty minutes time; and if the whole are not in use, the lead pipes of those not wanted may be plugged up. Each tub and cover is held down by four levers, and an iron ball at the end of each lever.

When the potatoes are sufficiently boiled by the steam, the crane N raises and removes the tubs from their places to the stone troughs U U, a section of one of which is given: the potatoes are there bruised for use.

XVIII. *A demonstrable, accurate, and at all Times practicable Method of adjusting* HADLEY'S *Sextant so as to render the* Back *Observation equally correct with the* Fore *Observation; and to measure an Angle of* 150, 160, *or* 170 *Degrees, as accurately as one of* 30, 40, *or* 50 *Degrees. Communicated to the Astronomer Royal by Letter dated Sept.* 28, 1803. *By the Rev.* MICHAEL WARD, *of Tamworth, Staffordshire.*

HAVING several years used a Hadley's octant by Dollond, of the common construction, to compute the time from the sun's double altitude, in order occasionally to examine the rate of going of a gridiron pendulum clock, I have often lost a number of observations from want of certain dependence on angles above 90°: the same inconvenience attended all attempts at revising a table of parallaxes of stars above 45° meridional altitude; and also all lunar distances above 90° required a more extensive instrument. The one I have, however, being, from its tried accuracy, a great favourite, it became more an object with me to invent some mode of bringing this instrument to measure larger angles than 90° than to purchase a more extensive one. Flattering myself that the subjoined experiments and observations will

will give, if not exactness, at least a demonstrable deviation within 15 seconds, I shall feel myself happy if what I communicate prove of service to others in its present state, or may give rise to any new ideas of improvement in the instrument itself.

It is a known principle in optics, that the angle of reflection is equal to the angle of incidence: hence the angle formed by B and C in fig. 1. (Plate III.) being greater than a right angle B receiving a ray and transmitting it to C, the consequence from the above principles is, AD becomes greater than AE; AE being equal to the distance of the reflecting points in B and C in the second figure, B and C forming a right angle, E and D coincide in the third figure; B and C forming an angle less than a right angle, AD becomes less than AE.

Let us now suppose the eye placed behind G in fig. 4, so as to observe or bring the point G upon A, and behind H in the line BH let the flame of a candle be placed; it is evident that the ray HB from the flame will fall upon B, be reflected to A, and be again reflected by A in the direction AG, so as to be distinctly seen by the eye behind G.

Unscrew the lever of the back observation glass, and, turning it round, adjust it like the fore observation glass: in this attempt it will be found necessary to remove the sight-vane to a new situation, which may be done by glueing a small bed of wood on the side at Z to hold it *.

Having

* It may be useful here to remark, that in upwards of 1000 altitudes of the sun, taken with my instrument with the back observation glass, turned as here described, and the sight-vane in a bit of wood fastened to the side, and all the opening of the back observation glass covered by pasting paper over its surface, except a strip exactly as broad as the opening, and at right angles to it, I have found, upon taking any *even* number of double altitudes of the sun, with their correspondent times, that when the average was found it *always* accorded in time and altitude with the middle place; whereas, when I have tried the fore observation glass in the same manner, it was frequently subject to deviation, and very seldom would bear apportioning, when both occupied the middle of the column. Let an example, taken yesterday, testify to what I assert.

1804, February 13	X	14	15	-	33°	51′	15″	
	X	15	2	-	34	0	30	
	X	15	40	-	34	6	40	
	Place of Average.							
	X	16	14	-	34	11	30	
	X	17	2	-	34	23	30	
	X	17	39	-	34	26	30	
	6	35	52	-	204	57	55	
	X	15	58	-	34	9	39	average

The

Having adjusted the *back* observation glass as for a *fore* observation, draw a pencil line from its centre to the centre of the hole in Z, and from the centre of the index glass let fall a perpendicular LM: this line in my instrument is 6·33333 inches.

Now GH being previously made equal to LM, and the index set to zero on the limb, turn the back glass to its *proper* situation, and adjust it as nearly as you can.

The line GH is now to be changed for the following apparatus:—In a scale of wood (fig. 5.) about five inches broad, a foot long, and an inch thick, let there be a slit made * two or three inches long, and not exceeding 1-30th of an inch in breadth: at 6·3333 inches from this slit let a scale of inches divided into tenths begin both ways; let a telescope, A, magnifying any number of times, from three or four to thirty, be so contrived as to move nearer or further from the slit by means of a screw, and also perpendicular to the plane of the scale; let the telescope also carry an index corresponding to the centre of the cross hairs within it; opposite to the slit let there be a socket to hold a small bit of candle. The whole will be easily comprehended by inspecting fig. 5.

Fix both instrument and apparatus on a plank, or in a box open at both ends, so that GM may, for a reason to be given below, be 176·88734 inches.

If GK exceeds GH, the angle ACB is then more than a right angle, and the angle KBH is double the angle SCB, for SCA is drawn to represent a right angle.

But if GK equals GH, the angle ACB is a right angle; and K and H coinciding, the angle KBH vanishes of course; SCB vanishes also, and coincides with the right angle SCA.

But if GK is less than GH, so as that K fall on P, then the angle AGB will fall within, or be included in the right angle ACS, and the index line GB will take an angular situation similar to that of the line CW, and the angle PBH will be double of the then angle SCW.

The reason why KBH is double the angle SCB is: Suppose a ray comes from G upon A, is thence reflected to B, the index glass B being set at more than a right angle to

The inference is, that by increasing the distance of the two reflectors and the eye, and confining the observation to a square about one degree, or double the sun's diameter, in breadth, the accuracy is considerably increased.

* The slit falls behind the flame in the engraving.

AC,

AC, whatever excess in *incidence* A receives, the same excess in *reflection also* it transmits to GK; of course, therefore, KBH is double SCB.

The apparatus being thus explained, and the principles established, let us now apply them practically to measure the angle KBH.

Let us first find the length of BH or GM.

From the property of the circle it is evident, that if the radius be 57·29578 inches, the sine of one degree will be one inch, and the sine and tangent of angles less than ten minutes have no discernible difference: therefore the sine may be used for the tangent: therefore 343·77468 inches radius will give six inches for one degree.

Now, six inches being divisible into sixty tenths, one-tenth of an inch will correspond to one minute: but, as has been already observed, the angle KBH will measure double the angle SBC; therefore *half* the radius with the same six inches sine, will measure out the minutes of the angle SBC at one-tenth of an inch for each minute.

Then 176·88734 inches must be the length of BH or GM.

If this length be doubled, then each tenth will measure thirty seconds.

If tripled, the divisions will be twenty seconds each, &c. &c.

Having placed the instrument, and directed the telescope along the line GM to A, light the candle and look for its reflection through the slit, and you will find three, five, or seven lines of light, but the middle one the brightest; bring that into the centre of the telescope by screwing the telescope nearer to or further from the slit, as occasion may require: then note at what division the index on the telescope stands: suppose it at 4½ of the divisions to the right, the instrument will measure all angles by back observation 4′ 15″ too much, yet subject to the laws of the back observation in the common way: thus an angle of 42° 52′ 30″ so taken, must be diminished to 42° 48′ 15″, and this taken from 180° leaves 137° 11′ 45″, the true angle: and so in other cases.

If this mode be not approved of, another, perhaps as accurate, may be tried. Set the index of the telescope to 0 on the scale of the apparatus, and the index of the instrument at 0 on the limb; then move the index of the instrument along the limb till the middle bright light occupies the centre of the telescope as before; and the angle of deviation,

tion, if to the *left*, must be *subtracted*, if to the right, added: thus 4′ 15″ in the example just given being to the right, must be added.

Many more, and perhaps useful observations, might be given, and a mode of setting both glasses perpendicular to the plane of the instrument by the use of the above apparatus; but I fear I have already exceeded the limits allowed to communications in a monthly publication, and shall therefore add no more—except to say, it will give me much pleasure to find the present communication considered as useful.

February, 14, 1804.

XIX. *On the Utility of the Oxygenated Muriatic Acid in the Cure of Scarlet Fever; with an easy Mode of preparing it for Medical Purposes. By Mr.* John Ayrey Brathwaite, *Member of the Royal College of Surgeons in London, and Surgeon to the Lancaster Dispensary* *.

Having frequently experienced the inefficacy of the common mode of medical practice in the Scarlatina anginosa, I have been induced to make some inquiries into the nature, cause, and treatment of that disease, which has been prevalent in this town and neighbourhood for three years last past. The result of my observations has been the discovery of a remedy in this disease, which is as much entitled to infallibility, as mercury in the lues, or bark in the ague: it is easily prepared, by any apothecary, of materials with which his shop is, or ought to be, always supplied; and requires no complex pharmaceutical apparatus with which those unaccustomed to practical chemistry are often liable, even from proper materials, to prepare chemical preparations totally different in their properties from those intended.

As I have no doubt but the contagion of the scarlet fever produces an extraordinary degree of disoxygenation of the system, with great debility, and exhaustion of the sensorial power; I was led to suppose that oxygen, exhibited in some easy and pleasant manner, might not only destroy the contagious matter adhering to the tonsils, uvula, &c., but, by penetrating the fine moist membrane of the lungs, and by chemical attraction uniting with the blood, excite the action

* Communicated by the Author.

of

of the arterial system, warming the extremities, increasing insensible perspiration, exhilarating the spirits, and, invigorating the vital principle without exhausting it, would prove an efficacious remedy in this but too fatal disease. This I have experienced in the oxygenated muriatic acid, whose known property of destroying putrid miasms, and preventing infection, in a gaseous state, has totally abolished the absurd farragos of antient practice.

Variolous and vaccine virus, exposed but for a moment to the vapour of oxygenated muriatic acid, lose their contagious properties; and the latter, rubbed with one-eighth of a grain of oxide of iron (*rubigo ferri*), will rarely communicate the disease: what then may we not expect from this active and elegant preparation! elegant I may justly entitle it, as, when properly prepared and sufficiently diluted, it may be administered to patients of all ages, being a safe and efficacious remedy, possessed of a slight degree of grateful acidity.

When called to a patient, in whatever stage of the scarlet fever, my practice for two years last past has uniformly been as follows:—One dram of oxygenated muriatic acid is mixed with eight ounces of distilled water in a vial, and shaken together: this quantity should be taken every twelve hours by a patient from fourteen to twenty years of age; but it is preferable to administer it in draughts divided from the quantity above mentioned into ℥ij, ℥iss, ℥j, and ℥ss bottles, as the patient's age and situation require, ordering them to be taken at such periods as for an adult to consume the quantity in the time mentioned, and to younger patients smaller doses, as half a dram or two scruples of the acid to eight ounces of water. By this method the oxygen gas is not separated and lost each time the vial is opened, as may easily be perceived by its smell in the apartment. It is also absolutely necessary the medicine be placed in a dark situation, wrapped in paper, to prevent the disoxygenating influence of light.

Since the use of this medicine I have never had recourse to emetics, purgatives, blisters, or diaphoretics; a regular perseverance in the oxygenant remedy has universally succeeded, my patients rapidly recovering, and being seldom afflicted with those complaints succeeding the scarlet fever, such as pain of the joints, paucity of urine, and universal anasarcous swellings. Even should these follow, I recommend a continuance of the medicine until these symptoms entirely disappear, which will be found much earlier than by the usual mode of treatment. Indeed, if the oxygenated preparation

preparation is duly persevered in, I am of opinion those painful and distressing affections will rarely occur. It is also possessed of this desirable property, that it may be easily taken by children, who generally are the most numerous patients in this disease, and to whom all medicines are administered with difficulty; I have frequently heard them cry for *that stuff which mended their throat*, as they expressed it: indeed in that respect its effects are truly admirable, far surpassing the disagreeable practice of gargling and syringing, which in numerous instances, even if possible to do it, is productive of mischief. How far superior then must be a remedy which, by passing over the infected and frequently ulcerated part immediately, not only gives instantaneous relief, but entirely removes that fetid smell originating in severe cases from these parts! Patients often wish to be frequently sipping a little of the oxygenant liquid: which is not improper; but it must always be done out of a wine glass, as admeasurement with a spoon is dangerous, the oxygen rapidly oxidating the metal of which it is composed, and by that means conveying into the stomach a poisonous fluid, from which death might ensue.

The muriatic acid has long been used as a medicine, and sir William Fordyce strongly recommended it in the ulcerated sore throat and putrid fever; but the oxygenated muriatic acid has, I believe, been rarely employed. Dr. Crawford * once took twenty drops of it, diluted with water; but soon afterwards found an obtuse pain, with a sensation of constriction in the stomach and bowels: this uneasiness, notwithstanding the use of emetics and purgatives, lasted for several days, and was at last removed by drinking water impregnated with sulphureous hepatic air: this effect he attributes to the manganese, which had been used in the distillation of the acid, containing a portion of lead. I should rather suppose it proceeded from the dose of twenty drops being taken. Oxygenated muriatic acid readily gives to living animal bodies its superoxygen, and the remains is common muriatic acid; a dose of which similar to the above would undoubtedly, in delicate constitutions, produce similar effects. In no case whatever have I found it necessary to exceed the quantity before mentioned, but it has sometimes been done by my patients through an anxious desire to get well: the same uneasiness has, however, been produced which Dr. Crawford experienced, though the preparation

* Philosophical Transactions, vol. lxxx.

was made so as not possibly to contain either lead or any other metallic substance.

To prepare the oxygenated muriatic acid in a perfect state of purity, put two ounces, by measure, of distilled water into a narrow tubulated bottle with a ground glass stopple; into this gradually pour, by measure also, as much muriatic acid, the specific gravity of which is as 1170 to 1000 of distilled water, frequently shaking the vial; add then to it two drams of oxymuriate of potash *, which in a little time will fall to the bottom, the acid seizing the small portion of alkali, and liberating beautiful globules of vital air, which slowly rise towards the surface, diminishing as they ascend, superoxygenating the acid: a little agitation now and then facilitates the process, but it will be three or four days before the acid becomes hyperoxygenated: the stopple should be put loosely into the vial and tied over with a piece of bladder, but not too tight, allowing it to move when the gas is rapidly extricated. This process should be performed in a dark situation, and the oxygenant medicine be after preserved, by putting over the bottle a circular piece of pasteboard, to prevent it from being injured by the deoxygenating power of light.

It is not in scarlet fever only that this preparation promises to be of advantage; I have found it useful in angina maligna and other diseases proceeding from or producing a deoxygenation of the blood: in many lingering cases of the late influenza it was exhibited with evident advantage, in the doses above mentioned.

From the trials made by Guyton Morveau and others, it appears that the oxygenated muriatic acid in a gaseous form possesses the power of neutralizing and destroying contagious miasmata, even in rooms where the sick are present, without the slightest inconvenience. Possessed of amazing expansibility, this gaseous oxygenant diffuses itself over the most extensive apartments, leaving nothing untouched, and touching nothing it does not appropriate; rapidly oxidating metallic bodies, particularly iron and steel, (which should be removed,) and radically destroying the most offensive odours, thereby rendering innocuous perhaps deadly contagious poisons.

To completely purify any apartment, where a patient suffers in the scarlet fever or any other contagious disease, so

* The best oxymuriate of potash I ever had, was made by Mr. Hoyle, an ingenious chemist in Manchester; 100 grains yielding nearly 74 cubic inches of oxygen gas.

as to render it perfectly safe not only to the attendants but to the rest of the family, take a china teacup and saucer, put into the cup two ounces of common salt and half an ounce of the black oxide of manganese, previously powdered, with one ounce of water; then take an ounce and half of sulphuric acid, and pour a little of it now and then into the teacup among the other ingredients: immediately an amazing quantity of oxygenated muriatic acid gas will be disengaged, and diffused through the apartment: this should be suffered to remain *only a few minutes*, removing it out of the room into the staircase; by which means the whole house will become impregnated with this gaseous oxygenant: it will be proper to take it into the room frequently during the day, adding to it a little fresh sulphuric acid, and then replacing it in its former situation.

It was my intention to have transmitted a more minute account of the scarlet fever, and its mode of treatment by this oxygenant remedy, illustrated with cases; but suffering at present under an arthritic complaint, I found myself inadequate to the undertaking: perhaps at some future period I may again take up the pen to corroborate what I have asserted: should this, however, be the means of rescuing one individual from a premature grave, the intention of the writer will in some degree be accomplished.

Lancaster,
March 1, 1804.

XX. *Report of Galvanic Experiments made on Men and Animals. Read to the Class of the Exact Sciences of the Academy of Turin by* C. Rossi*.

I. *Experiments on Rabbits suffocated in Water.*

Thermometer 7°†; barometer 27 inches; pile 25 disks.

Having cut off the hair from the nape of the neck and the stomach of a rabbit, I suffocated it in a pail of water, and, as it gave no apparent signs of life, I galvanized it for twenty minutes: but in vain, as it was really dead. I did the same thing to another, which I drew sooner from the water, that is to say, while it still exhibited signs of life; but I was not able to save it by means of galvanism.

* From the *Journal de Physique*, Vend. an. 12.
† We suppose Reaumur's is meant = 44·6 Fahr.—Edit.

I 2 A third.

A third, being taken sooner from the water, was saved; though it had already experienced a convulsive cough, and in all probability would have died without the assistance of the pile. This convulsive cough gave me reason to suspect that a small quantity of water had penetrated through the larynx and the trachea into the bronchiæ and pulmonary vesicles, which prevented inspiration and expiration, like an organic defect, or as an obstacle to these functions, while it causes the glottis also to remain shut in asphyxiæ of this kind*. It is for this reason that the application of galvanism is in general ineffectual in such cases, if an artificial aperture be not previously made in the trachea to admit air, which, as a stimulant proper to the lungs, by exciting a cough, may cause the small quantity of water lodged in these cavities to be thrown up. If the animal be then galvanized as above, it may be recalled to life with greater certainty, provided the excitability of the heart and lungs be not absolutely destroyed, as I have mentioned in the article of Bronchotomy, in my Treatise of Chirurgical Operations.

To satisfy myself on this point, I suffocated a fourth rabbit in the same medium, and, having examined the state of the aërian passages, I discovered that the glottis was shut by a spasmodic falling down of the epiglottis; the trachea and the bronchiæ were empty; but in the pulmonary vesicles I found a small quantity of water, sufficient in this case to oppose the return of the pulmonary functions, unless an artificial passage be opened as already remarked: this quantity of water was indeed so small that it would not have been capable to produce any derangement in the above vesicles, had the atmospheric air been at liberty to exercise an action on the exterior surface of the breast.

To assure myself of these principles I suffocated a fifth rabbit, prepared like the rest, immersing in the water the head and shoulders only. After struggling some time, it suddenly ceased to move; on which I galvanized it for ten minutes; when it recovered.

It is my duty to state, that in the first the water had penetrated the pulmonary vesicles; and when this is the case it is needless to turn down the animal's head, as some have proposed: in the last, the small quantity of water which entered by incomplete inspiration had not gone beyond the commencement of the bronchiæ.

* I am not ignorant of what has been done by Troja and other physicians.

II. *Expe-*

II. *Experiments on Rabbits suffocated in Sulphurated Hydrogen and Carbonic Acid Gas.*

Thermometer 8°*; barometer 27 inches; pile 25 disks.

It is much easier to recall animal life in these cases of asphyxia, because there is no mechanical obstacle to the functions of the respiratory organs, and as the glottis generally remains open. Having prepared a rabbit, and suffocated it in sulphurated hydrogen gas, (a mode which occasions no agitation in the animal as water does, because it first renders the nervous system torpid, and then extinguishes the property of transmitting the animal fluid capable of exciting the animal and of preserving it in life,) in three minutes after apparent death I galvanized it, forming the circle as before mentioned during three minutes, and observed movements either in the feet or at the stomach. These movements increasing by the continued action of the fluid of the pile for eight minutes more, effected a return of respiration and of life at the same time; but the animal remained apoplectic. To bring the animal from this state, I applied galvanism, with great precaution, to the external part of the nostrils, and at the same time made it drink vinegar. By these means the functions of the external senses returned twenty-three minutes after suffocation, but it remained stupid for four hours.

I must here observe, that I had before suffocated two others on which galvanism produced no effect, probably because it was too late.

Another rabbit, prepared and suffocated in carbonic acid gas as the preceding, was subjected to galvanism for eighteen minutes, but without success. Finding that there were no hopes of recalling it to life, I formed the resolution of opening the cavity of the breast and the pericardium. I then galvanized the diaphragm, forming the circle between it and the spinal marrow; and though the contractions of that muscle were sufficient to excite some movement in the heart, they were not able to maintain it for any length of time. I then applied the galvanic circle to the nerves of the heart, and to the heart itself: it was now twenty-six minutes after suffocation, contractions were manifested in the above organ, and in consequence of the galvanism were repeated at intervals, and continued to forty-six minutes. I then directed the action of the galvanism to the muscles

* 8° Reaum. = 46·4 Fahr.

of the extremities, which gave contractions till fifty-eight minutes; when all motion ceased.

I repeated the same experiment on a similar animal, taking care not to begin till eighteen minutes after: it was preserved from death, but remained apoplectic for nine hours. At this period it was completely restored by swallowing a little vinegar. I then suffocated a third in the same gas; and after galvanizing it for sixteen minutes without hopes of reviving it, I electrified it positively, and also applied galvanism. I immediately observed, with surprise, distinct pulsations of the heart, and at the same time some respiration, for about eleven minutes; but these movements ceased at the end of eighteen minutes, after which it was really dead. From this fact it would appear that some doubts might be entertained in regard to the different nature of these two fluids; that is to say, vitreous electricity, and that of the pile. I do not, however, see that their nature is essentially different. I rather observe a difference of condition between them, and particularly in their manner of acting on animals; for an animal electrified positively when it still retains a certain power to animalize the electricity, is put into a state capable of supporting a stronger excitant, such as the fluid of the pile, which is also electric but differently modified, which being applied to animals the organs of which are already deprived in a great measure of the property of feeling the stimulant, on which they cannot, as we may say, re-act, must be considered as capable of speedily annihilating the little vitality still existing in the same organs, unless applied with great circumspection. It may therefore be laid down as a general principle, that when excitability is accumulated it may always be employed with advantage; that when real indirect debility exists, recourse must be had to it with caution, and it must be applied only by degrees; and, lastly, that if the patient is asthenic, the use of it may become fatal.

To throw more light on this difficult point in regard to the application of galvanism, I shall resume other experiments, which will form the subject of another memoir, containing a detail of several cures obtained by means of the above fluid, and among others of partial palsies, and of a case of hydrophobia, which C. Vassalli-Eandi has already announced in his letter to C. Rossi. You will observe that the above-mentioned experiments, as far as concerns the duration of vitality in regard to galvanism, do not exactly correspond in all animals; which proves that the vitality of animals,

animals, whether warm or cold blooded, is not equal in all, though in general the products are equal.

III. *Experiments made on a Man decapitated on the* 18*th of January.*

Thermometer $6\frac{1}{2}°$*; barometer 27 inches; pile 50 disks; solution, muriate of soda.

A robust man, aged thirty, was decapitated at forty-six minutes after eleven, on the 18th of January. The body was immediately conveyed to the hospital of St. John, where it arrived at fifty-nine minutes after eleven. The thermometer was at 7°, and the barometer at 27 inches: the pile was composed of fifty pairs of disks, and the paste-board was moistened with a solution of muriate of soda. The series of experiments were immediately begun.

The first was to excite the diaphragm without applying an armature to the spinal marrow, as is generally done. Having applied the conductor of the positive part to the spinal marrow, and that of the negative to the pit of the stomach, previously moistened with the solution of muriate of soda, the movements excited in the diaphragm were very strong, and those of the heart were no less so. The lungs performed several expirations, charged with vapours which at each expiration covered with aqueous drops the surface of a glass plate even when the conductors were no longer applied. The movements of the heart, which had been excited by those of the diaphragm, continued for three minutes, and were distinctly felt on applying the hand to that region.

Eighteen minutes after decapitation the cavity of the thorax was opened, and the diaphragm was then irritated with the point of a scalpel: the movements were sufficiently strong to excite also the heart; but the movements of the latter could not be preserved by that stimulus as they were by the pile, even when the conductors were no longer in contact with the before-mentioned parts. I then applied, as before, the conductors to the spinal marrow and the diaphragm, and the contractions excited were so strong that the heart was put in motion for five minutes.

Having removed the left lung to uncover the thoracic aorta, I applied the conductor of the positive part to the heart, and that of the negative to the aorta. The movements of the former were very brisk, and were exceedingly

* 6·5 of Reaum. = 43·7 Fahr.

striking in the aorta. At twenty-three minutes after decapitation I cut the thoracic aorta near its passage into the diaphragm, and it was taken from the thorax, with the heart, and insulated on a plate of glass. I insulated also a portion of the anterior straight muscle of the left leg, and at thirty minutes after decapitation I began to irritate the heart with the scalpel; but the contractions were very feeble: those of the straight muscle, excited with the same stimulant, were much stronger; but it was not possible to produce the least effect on the aorta.

Thirty-four minutes after decapitation I made use of the pile: it excited pretty strong contractions in the heart, still stronger in the straight muscle, and a few faint contractions in the aorta, which soon ceased entirely. I continued the experiment, sometimes irritating the heart and the muscle with the scalpel, and sometimes with the fluid of the pile, till fifty minutes, when the movements of the heart disappeared altogether, while those of the muscle were still visible by means of the scalpel, and very strong by means of the pile.

I opened the cavities of the heart, that is to say, the ventricles and auricles: the scalpel produced no effect, the pile alone was capable of exciting some faint movements in the ventricle and right auricle. At this period, that is, at fifty-six minutes after decapitation, the scalpel still produced some effects in the insulated straight muscle; but the pile excited in it very strong contractions, which continued till an hour and eighteen minutes; after which they entirely ceased.

I then turned my observations to the muscles of the extremities left in their place: in these the scalpel occasioned sensible contractions, which increased very much in strength by means of the pile: they still continued one hour and fifty-three minutes, at which time I left off my experiments.

These results are perfectly analogous to those which I communicated to the class in regard to dogs which had been decapitated; it is therefore needless to repeat the consequences which ought to be deduced from them. Besides, they will be found in the memoirs, which, by a decree of the academy, will be inserted in the volume now in the press. I shall only observe, that if the theory of Crawford and Lavoisier on animal heat is the most correct of any yet formed on that subject, and if the assertion of Humboldt on the property which he ascribes to oxygen, of nourishing vitality, be true; these experiments will oblige us to conclude

clude that the blood of the venæ cavæ deposited in the right auricle, though surcharged with carbon, has not power to destroy vitality, like the blood in the pulmonary veins, which, according to the received doctrine of animal heat, is charged with the recent product of respiration, and which is afterwards deposited in the left auricle. In this case, Haller, and all those who believe that carbon is the destroyer of vitality, would be wrong, or the said theory must be defective. For the left auricle, which during the life of animals that respire, and which have the heart divided into four cavities, is in contact with the blood, charged with the products resulting from respiration, is of all the cavities of the heart that which loses vitality soonest,—though, according to Humboldt, oxygen is the nourishment of vitality; while the right auricle, which is the last to lose it, is, during the life of these animals, forced to receive the blood surcharged with carbon.

IV. *Galvanic Experiments made on a Man decapitated January the 22d.*

Thermometer $6\frac{1}{2}°$ *; barometer 27 inches; pile 50 disks: solution, muriate of soda.

A young man, thirty years of age, stout and robust, was decapitated on the 22d of January at noon. The body was transported to the anatomical theatre of the hospital of St. John, where it arrived at six minutes after noon. The persons present were, Vassalli-Eandi and myself, professor Anselmi, Geri, Giorcelli, and Massi, members of the college of surgery, the chief of the gendarmerie of the 27th division, and several others. As soon as it arrived, the experiments were begun.

The object of the first experiment was to excite the diaphragm. The conductor of the positive part was applied to the spinal marrow, where it was cut, and that of the negative to the pit of the stomach: very strong expirations were immediately produced, and the glass plate was covered with vapour. The heart was put in motion, and was still in that state when the cavity of the thorax was opened to excite it by the mechanical stimulus of the scalpel; and by these means also it experienced contractions. Those excited at the commencement of the experiment, and which had already decreased, were renewed. The pile was then employed as before, and the diaphragm exhibited contractions so strong, that they made those of the heart four times

* 6·5 Reaum. = 43·7 Fahr.

as

as strong as they had been when excited by the stimulus of the pile: they continued till fourteen minutes, though those of the diaphragm had ceased.

I then removed the left lung to uncover the thoracic aorta, and at seventeen minutes we applied the conductors to the heart and the aorta near the diaphragm: the contractions of the former were very strong, while those of the aorta were such that they approached the heart, where the conductor of the negative part was applied. Vassalli-Eandi, who measured them with his decimetre, found that the shortening of the aorta was a millimetre. Immediately after, I cut the aorta transversely near its insertion in the diaphragm; and, having repeated the experiment as above, the shortening at twenty-one minutes after decapitation was about two millimetres. At twenty-four minutes the heart was insulated with a part of the aorta on a glass plate. A portion of the aorta a decimetre in length was also insulated on the same plate with a part of the same length of the sartorius muscle, while an assistant uncovered the muscular tunic in a determinate place of the small intestines. Every thing was ready at the twenty-sixth minute, and the experiments were begun by irritating all these parts with the point of the scalpel.

The results were as follow:—1st, The heart, with the small part of the aorta still attached to it, gave moderate contractions, while the separated portion made only some faint movements; but those in the sartorius muscle were very strong. 2d, The conductor of the positive part being applied to the small portion of the aorta still attached to the heart, and that of the negative to the apex of the heart, produced movements of systole and diastole much stronger in all the four cavities, and even in the continued part of the aorta, which shortened about a millimetre. The separated portion of this aorta, the two conductors being applied to the two ends, gave contractions, or rather became shortened about a millimetre. The portion of the sartorius muscle exhibited a shortening of fifteen millimetres.

I then applied the conductor of the positive part to the spinal marrow of the neck, and that of the negative to the place of the muscular tunic, which had been freed from its peritoneal covering, on which the movement of the intestines was peristaltic; and when the conductor of the negative part was introduced into the anus, the contrary motion took place. Thirty-four minutes after decapitation the parts were left at rest till the thirty-sixth minute, and in that interval I uncovered the anterior straight muscle of the left leg;

after

after which we repeated, with the stimulus of the scalpel, the experiment before described. The results were: 1st, Some visible movements in the ventricles of the heart and the left auricle, more visible in the right, but none in the separated portion of the aorta. In the portion of the sartorius muscle we observed very strong contractions, as well as in the intestines, and very strong contractions in the straight muscle of the leg. 2d, With the pile we excited movements of systole and diastole very sensible in the four cavities of the heart, but still more sensible in the right auricle, and without any appearance in the portion of the aorta. We remarked a shortening of twelve millimetres in the portion of the sartorius muscle: the movements of the intestines were pretty strong, and those of the straight muscle of the leg very strong. At forty minutes the experiment was suspended till the forty-fifth. After this term, having resumed it as before, the results we obtained were as follow:—The scalpel exercised scarcely any action on the left ventricle, and none in the left auricle. There were pretty apparent movements in the right ventricle, and still more apparent in the right auricle: we found that those of the portion of the sartorius muscle were two millimetres: none were excited in the intestines, but there were very strong movements in the straight muscle. 2d, On the other hand, we obtained by the pile very faint movements in the left ventricle and auricle, more apparent in the right ventricle, and still stronger in the right auricle. Those observed in the portion of the sartorius muscle were ten millimetres, and very visible ones were perceived in the intestines; very strong in the before-mentioned anterior straight muscle. At fifty minutes after decapitation all the parts were left at rest till fifty-three minutes. During this interval I uncovered and cut transversely the sartorius muscle, and we then repeated the experiment as before. The results we had with the scalpel were as follow:

1st, The left ventricle and auricle gave no marks of sensibility; those exhibited by the right ventricle were scarcely perceptible, while the right auricle gave very strong movements: those of the portion of the sartorius muscle were three millimetres. The intestines were not irritated, but the straight muscle and the two parts of the left sartorius gave very strong contractions. 2d, By making use of the pile, the left ventricle exhibited only very slight movements, and none were produced in the auricle of the same side. The movements in the right ventricle were more apparent, and still greater in the auricle of the same side. In the portion

of the sartorius they were six millimetres. The contractions of the straight muscle were very strong, and they were nine millimetres in the two portions of the straight sartorius, which was attached to the respective points. Fifty-nine minutes had elapsed after decapitation, and the experiments were continued on the same parts; and it was not till an hour and twenty-three minutes that they were abandoned. I shall not give any detail respecting them, because they were made in the same manner as the preceding. The results, however, were as follow:—The aorta first ceased to exhibit contractions which were excited by means of the two stimuli before mentioned; the other parts ceased their movements in this order: the intestines, then the left cavities of the heart; the right ventricle and the right auricle the last: after the right auricle, the insulated portion of the sartorius muscle, while the muscles in their places still exhibited very strong contractions. It was then thought useless to continue the experiments, since it was proved that the voluntary muscles were the last to lose their movement.

XXI. *A Report of the State of His Majesty's Flock of Fine-woolled Spanish Sheep during the Years* 1800 *and* 1801; *with some Account of the Progress that has been made towards the Introduction of that valuable Breed into those Parts of the United Kingdom where fine Clothing Wools are grown with Advantage.*

On the 9th of June 1800, when his majesty's Spanish flock was shorn, it consisted of 100 ewes and wethers, which produced as follows:

Wool washed on the sheeps' back -	398 lb.
Loss in scouring - - -	104
Amount of scoured wool - - -	294

Which produced, when sorted,

Prime	234 lb.	at 5s. per lb.	65l. 11s.
Choice	34,	at 3s.	
Fribbs	26,	at 1s. 6d.	

Eight rams and nine ewes were this year disposed of, which were all that could be spared from the flock. Two of the rams went into Dorsetshire, where the breed is much approved by some skilful judges of sheep, and seems likely to produce considerable advantage by crossing with the common sheep of the country.

Mr.

Mr. Bridge, of Winford Eagle, communicated this year the result of an experiment he had made on three kinds of sheep; viz. Dorset, half Spanish and half Dorset, and half Spanish and half Mendip.

He kept these sheep from the year 1798, when they were lambed, till February 1800, when they were butchered as fat sheep; and having valued them in June 1798, he found the carcases of each sort, with two years wool which had been shorn from them, to yield at that time the following increase in value:

Real Dorset - - -	4l.	5s.	6d.
Half Spanish half Dorset -	4	3	8
Half Spanish half Mendip -	3	19	2

In these experiments Mr. Bridge's woolstapler values the Dorset wool at 1s. 2½d. a pound, and the half Spanish wool at 1s. 4½d. only; but as the Spanish cross in both cases increased the quantity of wool, and as half Spanish wool has never, when its value was properly known, been sold for less than 1s. 9d. and generally more than 2s. a pound, there can be no doubt that the improvement in value, arising from the cross, is in both cases considerable.

Mr. J. Ridgeway, of Upperton, in the parish of Yazor, in Herefordshire, communicated an experiment, in which two sheep, the one a Ryeland and the other half Spanish and half Ryeland, of equal weights, were fed by him together: the half Spanish sheep produced in a year 2lb. 12oz. more wool and 5lb. more mutton than the Ryelander. This gentleman, whom his majesty graciously permitted to have rams from the Spanish flock some years ago, has also shown by his accounts that the wool of his flock, of about 16 score sheep, has been so much increased both in quantity and in value by the Spanish cross, as to have produced nearly twice as much money for each clip after the Spanish blood was established in it, as it usually did before.

In June 1801, the Spanish flock consisted of 108 ewes and wethers,

Which produced in wool, washed on the sheeps' back,	397 lb.
Loss in scouring - - -	112
Amount of scoured wool - -	285

Which produced, when sorted,

Prime	237 lb.	at 5s. 6d. per lb.	72l. 1s. 9d.
Choice	31,	at 3s. 6d.	
Fribbs	17,	at 1s. 9d.	

The wool of the rams and fatting wethers, which had been

been kept separate, was prepared for sale at the same time; and produced in

Wool on the sheeps' back	-	220lb.
Loss in scouring	-	82
Amount of scoured wool	-	138

Which produced, when sorted;

Prime	96lb.	at 5s. per lb.	30l. 6s.
Choice	30,	at 3s. 6d.	
Fribbs	12,	at 1s. 9d.	

This year, eight rams and twenty-two ewes were sold. If the foot rot had not unfortunately damaged the rams very materially, more of them would have been disposed of. It is however observable, that although the rams that are kept at Windsor in rich land are occasionally attacked by this harassing disease, the ewes and wethers that feed on the dry and hilly pastures of Oatlands have never been subject to lameness of any kind.

Eleven wethers that had been sent to the marshes in order to try the effect of rich pasture in fattening sheep of this breed, were slaughtered this year by Mr. King, of Newgate Market, previous to the Smithfield meeting, which usually takes place the week before Christmas. Two of the carcases were given to persons who had been useful in ascertaining the value of the Spanish breed; the remaining nine were sold to Mr. Giblet, butcher, in Bond-street, whose judgment in selecting, and liberality in purchasing, the best carcases is well known, both to those of whom he buys and to those who buy of him. The sale bill is as follows:

				£.	s.	d.
1 Sheep, 6 stone	6lb.	at 6s. per stone	-	2	0	6
1 Ditto 7	0	6s.	-	2	2	0
1 Ditto 6	1	6s.	-	1	16	9
1 Ditto 7	2	6s.	-	2	3	6
1 Ditto 5	6	6s.	-	1	14	6
1 Ditto 5	2	6s.	-	1	11	6
1 Ditto 5	7	6s.	-	1	15	3
1 Ditto 5	4	6s.	-	1	13	0
1 Ditto 6	2	6s.	-	1	17	6
11 Heads and plucks, at 1s.			-	0	11	0
10 Stone 4lb. fat, at 3s. 10d.			-	2	0	3
				19	5	9

Respecting the goodness of the mutton, inquiry must be made of Mr. Giblet, at whose shop the carcases were shown for

for several days, and of his customers who purchased the joints. Experience has, however, demonstrated already, both at Windsor and at Weybridge, that Spanish mutton is of the best quality for a gentleman's table.

The pelt wool of these eleven sheep was taken off, in order that its value might be ascertained.

It weighed in the yoke	-	36lb.
Loss in scouring	- -	8
Amount of scoured wool	-	28

It was sold as skin wool for 4s. 6d. a pound, and of course produced 5l. 19s. or 10s. a sheep, all expenses deducted. The amount of this profit was quite unexpected; and holds forth a source of advantage in this breed, that has not probably hitherto been calculated upon.

Of all who have laboured to render his majesty's patriotic views in importing Spanish sheep permanently useful to his subjects, Dr. Parry, of Bath, deserves the highest commendation. Amidst the labours of a profession always toilsome when successful, and particularly so at Bath, where persons, whose diseases cannot be ascertained by the faculty elsewhere, continually resort, the doctor found leisure to employ himself in the improvement of the British fleece, by crossing various breeds with Spanish rams presented by his majesty to the marquis of Bath and to the Bath Agricultural Society.

The prizes the doctor has continually obtained from the judicious and respectable body from whom he borrowed rams, for cloths made of his own wool, in the midst of a manufacturing country and amongst abundance of able competitors, prove to a demonstration that he has brought the fleeces of the mixed breed very nearly to the value of the original Spanish; nor is this to be wondered at, when we recollect that the effect of a mixture of breeds operates in the following proportions:

The first cross of a new breed gives to the lamb half of the ram's blood, or	-	50 per cent.
The second gives	- - - -	75
The third	- - - - -	$87\frac{1}{2}$
The fourth	- - - - -	$93\frac{3}{4}$

At which period it is said, that if the ewes have been judiciously selected, the difference of wool between the original stock and the mixed breed is scarcely to be discerned by the most able practitioners.

More need not be said of the doctor's merit: his book, which

which every man who wishes to improve wool ought to read, will give a more just idea of the acuteness of his discrimination, the diligence with which he pursued his purpose, and the success that finally attended his judicious management, than can be stated in the brief form of a report like this.

Much, however, as Dr. Parry deserves the gratitude of all who honour the fleece, lord Somerville's merit stands at least as eminently conspicuous. Emulating the example of his sovereign, his lordship, whose just discrimination of the value of different breeds of stock is admitted by the most experienced agriculturists, made a voyage to Portugal for the sole purpose of selecting, by his own judgment, from the best flocks in Spain, such sheep as joined in the greatest degree the merit of a good carcase to the superiority in wool which the Merino flocks are allowed to possess.

His lordship succeeded, and brought home, more than two years ago, a flock of the first quality, which will probably repay with advantage the costs of the undertaking, as some of his lordship's rams are said to have been already sold for 100 guineas each.

As ten crops of wool have now been shorn from his majesty's Spanish flock, and not a single sheep from Spain has been introduced into it during the whole of the ten years that have produced them; and as the tenth crop afforded nearly five-sixths of prime wool and only one-fourteenth of fribbs; it is to be hoped that the deep-rooted prejudice which has for ages deceived the people of England into an opinion that Spanish wool degenerates in this climate, will now be finally lodged in that catalogue of vulgar errors which the increase of human knowledge daily enlarges. It is to be hoped also that a bold assertion hazarded here, that the mutton of Spanish fine-woolled sheep is coarse, tough, and little better than carrion, will be contradicted by the evidence of Mr. Giblet and his customers, to the satisfaction of those who have unwarily given credit to it.

His majesty having been pleased to permit the sale of such sheep as can be spared from the Spanish flock to be continued, the rams will be delivered at Windsor, and the ewes at Oatlands, in the latter end of August. As, however, it has been suggested to his majesty that the carcases of the sheep are evidently improved, and that the wool has rather gained than lost in value, six guineas will in future be the price of a ram, and two that of an ewe. And as his majesty has been graciously pleased to continue to intrust the management

nagement of the flock to Sir Joseph Banks, all letters on the subject of it, addressed to him in Soho-square, will be answered, and the utmost endeavours used to consult the convenience of those who wish to become purchasers.

July 1802. JOSEPH BANKS.

XXII. *Medico-chemical Researches on the Virtues and Principles of Cantharides: extracted from a Memoir of* C. BEAUPOIL *by* C. DEYEUX*.

THOUGH the animal kingdom affords only a small number of substances which can be employed in medicine, it must still be allowed that among those to which it has recourse, there are some the effect of which is so certain, so constant, and so striking, that if they were wanting it would be impossible to find others to supply their places.

Cantharides in particular are of this number. Every body knows the manner in which they act, and the resources they afford in a variety of diseases. It needs therefore excite no surprise, that an examination of these insects should at all times have engaged the attention of the most celebrated physicians, and that chemists have often tried to subject them to analysis.

The principal object of all those who have laboured on cantharides has been to discover whether the vesicant property, which they possess in the highest degree, belongs in general to all the parts of the animal, or whether it does not rather reside in a particular matter, which, independently of those that accompany it, can act alone, and give rise to the effects produced by the whole cantharides.

It would no doubt be superfluous to relate here every thing which has been done or said on this subject; but it is of importance to remark, that no one before Thouvenel pursued the route which would lead to a solution of the proposed problem: it has been therefore since the period when that physician published the different experiments he made on cantharides, that any hopes have existed of obtaining more accurate knowledge respecting the properties of the immediate materials of these insects.

However, in rendering justice to the efforts made by Thouvenel, it must be allowed also that he has not carried to a sufficient length the labour which he commenced so

* From the *Annales de Chimie*, No. 142.

well, since he neglected some of the most important questions necessary to be treated, and particularly those which relate to the vesicant, diuretic, and aphrodisiac, properties of cantharides.

To supply in some measure the silence he has observed on these three points, Beaupoil has thought proper to examine cantharides again. The dissertation in which he has published his experiments having appeared to me worthy of being known, I shall give an extract from it.

The author divides this dissertation into four parts.

In the first he gives a cursory view of the specific characters of cantharides; the processes employed to collect them; and the preparations to which they are subjected before they are introduced into commerce for medicinal purposes.

In the second he gives a short account of the use made of these insects since the days of Hippocrates to the present period.

The third contains a correct account of the attempts made by chemists to analyse cantharides, as well as a view of his own experiments, and of the results he obtained.

The fourth contains every thing that relates to the physiological essays made with these animals; to the effects produced by the external application and internal administration of them; and observations on the phænomena observed on opening several dogs, which the author caused to swallow either whole cantharides or their different immediate principles, which he was enabled to separate by means of particular processes.

As the first and second part contain nothing which may not be found in various authors, I shall proceed to the third part, which is merely chemical.

It has already been observed that Thouvenel was the first who examined cantharides in a manner likely to prove useful. Water and alcoholic fluids were, in particular, the two agents which he thought proper to employ in preference for separating from these insects the soluble parts which he expected to obtain. The results by means of these two fluids were:

1st, A reddish yellow extractive matter of a pungent bitterness, similar, he says, to that of ants, except its being less acid.

2d, A yellow matter less dark than the former, and almost insipid.

3d, A fat matter of a green colour, of an acrid savour, and having the smell peculiar to whole cantharides.

 4th, A

4th, A parenchymatous matter.

Similar products were obtained by C. Beaupoil: but, instead of being satisfied with ascertaining their existence, he examined them separately; and in this consists the chief difference between his labour and that of Thouvenel.

He first remarked, that the aqueous solution of the kind of extractive matter furnished by cantharides soon experienced a sort of alteration when exposed to the air; that the liquor became turbid, formed a yellow precipitate which acquired a peculiar odour, became covered with a viscid pellicle which emitted a fœtid ammoniacal odour; and that when it arrived at this term the same liquor exhibited no longer any sensible change. He then remarked that the solution in question, before it experienced all the changes occasioned in it by exposure to the air, gave a strong red colour to tincture of turnsole; that when mixed with rectified alcohol, or with ether, it divided itself into two parts nearly equal, one under the form of a black glutinous precipitate insoluble in alcohol, and the other under that of a yellowish brown matter exceedingly soluble in alcohol.

He ascertained also that the black precipitate dried readily in the air, became brittle and friable, and reddened tincture of turnsole; that it combined very well with potash, suffering to be disengaged ammonia; that when distilled over an open fire it swelled up and gave an acid liquor, a thick oil and carbonate of ammonia, and that it left in the retort a dry, brittle, and friable charcoal.

Proceeding then to examine the yellow matter which remained in solution in the alcohol, C. Beaupoil asserts, that when it is concentrated by the evaporation of its solvent, it retains the same odour and the same savour as the extract; that it dissolves completely in water, and reddens tincture of turnsole; that it combines wholly with potash without any disengagement of ammonia; and that this combination results from a homogeneous and glutinous body soluble in water, and capable of being precipitated by a weak acid; and, in the last place, that when distilled over an open fire it swells up very little, gives an acid liquor, a black fœtid oil, and carbonate of ammonia; but that all these products are in general less abundant than those obtained from the black precipitate.

Of these different results the author thought it his duty to attend more particularly to the acid, which, as seen, is so easily observed in the infusion of cantharides, or in the extract which they furnish.

He at first supposed that this acid was analogous to that

 of

of vinegar: he even thought that the existence of it might be ascribed to the practice adopted by those who collect cantharides, of exposing them to the vapour of that acid; but having subjected to experiment some of these insects, collected without the aid of vinegar, he saw that they exhibited the same phænomena as those of the shops. He was therefore obliged to renounce his first idea, and to attempt to ascertain by experiments the nature of the acid presented to him. It, however, appears that all his efforts in this respect were entirely fruitless; for he at length concludes that he is not yet enabled to give a decisive opinion; and that, though the acid in question has some analogy with the phosphoric, he thinks that it does not possess all its properties, and therefore that it ought to be placed in a particular class, until that which it ought to occupy shall be fixed by new experiments.

The third product of cantharides, called by Thouvenel and Beaupoil the green matter, does not seem to experience any alteration in the air, at least in its physical properties. It is insoluble in cold water; it liquefies in hot water, on which it floats in the manner of oil: alcohol and ether both dissolve it, and in these two menstrua it is decomposed by water. Oxygenated muriatic acid brought into contact with this matter, and renewed from time to time, does not at first appear to have any action on it; but small whitish and shining scales, which fall to the bottom of the vessel, are gradually seen to detach themselves from it: in less than eight days it loses its odour and colour, becomes thick and glutinous, and, notwithstanding several lotions, it always retains the odour of the oxygenated muriatic acid.

Diluted nitric acid assisted by heat gives it a russet colour, a rancid and pungent odour, and even a pretty strong consistence.

Caustic soda unites with it without the aid of heat, and without the disengagement of ammonia. The product of this union is decomposed by acids.

When exposed to the highest degree of heat it fuses and forms a liquid, as it were, oily and slightly transparent, which by cooling soon resumes the solid state. In a stronger heat it is decomposed, its colour changes, and there passes over into the recipients a yellowish oil, very analogous to that furnished by yellow wax when distilled, an acid phlegm, but not an atom of carbonate of ammonia.

In regard to the parenchyme, which forms the residuum of the different macerations, infusions, and decoctions, in water, alcohol, and in ether, the author, after ascertaining that

that these fluids could extract no more, subjected it to the action of caustic potash, which caused immediately to be disengaged a very sensible odour of ammonia. When this odour was once dissipated the liquor was filtered, and immediately mixed with muriatic acid. The mixture became turbid, and gradually produced a precipitate, which, when dried and put upon burning coals, exhaled an odour similar to that of animal matters in a state of combustion.

Distilled in a retort this parenchyme gave a phlegm, thick empyreumatic oil, and a very large quantity of carbonate of ammonia. The residuum of the distillation presented a kind of charcoal, from which was obtained, by incineration in the open air, a kind of white ashes, in which were found carbonate of lime, phosphate of lime, sulphate and muriate of lime, and oxide of iron.

Taking into account the quantity of each of the products obtained by means of the above experiments, the author asserts that an ounce of cantharides well dried contains

	Gros.	Grains.
Black matter - - -	1	2
Yellow matter - - -	1	2
Green matter - - -	1	8
Parenchyme - - -	4	36
Acid - an indefinite quantity.		
Phosphate of lime - - -	0	12
Carbonate of lime - - -	0	2
Sulphate and muriate of lime -	0	4
Oxide of iron - - -	0	2

To complete the labour which C. Beaupoil had undertaken, it still remained to determine the physiological properties of cantharides, as well as those of their most essential immediate properties. This he appears to have performed with considerable success in the fourth part of his dissertation. Besides other results, he found the following from the experiments he made on this subject:

1st, That cantharides which have been subjected to no preparation almost always produce disagreeable effects when taken internally; but these effects are relative, according to their intensity, the age, strength, and constitution of the animals, and the dose administered to them: that the œsophagus, stomach, and small intestines, are the parts particularly affected; that such animals as do not fall a sacrifice to their effects experience a desire to puke, very severe pains, and various accidents, which seem to announce that the parts touched by the cantharides have a tendency to become disorganized.

 2d, That

2d, That aqueous extract of cantharides in less doses than cantharides themselves, gradually produces the same effects; but that its action on the urinary passages is more striking.

3d, That the black matter is much more active than the extract; that animals to which it is given are subject to pain and vomiting, but rarely any of them perish.

4th, That the green matter given internally does not seem to have deleterious qualities, since all animals to which it is administered, even in pretty strong doses, have not seemed to experience any bad effects.

5th, That the yellow matter does not appear to be more active than the green matter.

6th, That the extract, the yellow matter and the black matter, applied all three separately to the surface of the body, produce the vesicant effect nearly in the same time.

7th, That the green matter applied externally seems not to act when alone; but that its action soon appears when mixed with wax, and when reduced by these means to the consistence of cerate.

I must not forget to observe that C. Beaupoil was not satisfied with trials made on animals, but had the courage to repeat them on himself. After acquiring all the information necessary, he thinks he is authorised to assert that the vesicant property resides essentially in the extractive and green part of the cantharides, but that the extractive part alone acts on the urinary and genital system.

From these details it is seen that the author has carried his examination of cantharides further than Thouvenel. But though his labour is very extensive it is still far from being complete, since many things remain to be done, particularly in what relates to the green matter; for it is difficult to conceive how, when administered internally, it has no action on the animal œconomy; while applied externally it produces the vesicant effect. This objection which I made to the author, and of which he felt the importance, will no doubt induce him to make new experiments, in order to ascertain what ought to be expected from the use of the different parts of this substance, from which medicine derives so great benefit.

XXIII. *Ob-*

XXIII. *Observations on the Prussic Acid, and the Production of a Pyrophorus by the Prussiate of Iron.* By D. H. Grindel*.

It is well known that Scheele, when distilling prussiate of iron per se, found that a part of the colouring matter passed over undecomposed, and was contained, in combination with ammonia, in the water that first passed over, and also in union with carbonic acid gas in the void of the receiver†. I had long intended to prosecute this experiment further, and to examine whether it was not possible in this manner, without further medium, to disengage the prussic acid in the gaseous form from prussiate of iron, to combine it with pure potash, and produce prussiate of potash free from iron. Late observations on the prussic acid in bitter almonds, &c. induced me to pay attention again to this circumstance, and I made the following experiments:

I. I put a small quantity of Prussian blue of the shops, finely pulverized, into a small glass fitted with a pneumatic tube, and heated the whole over a spirit lamp, after the tube and the glass had been closely united. As soon as a strong smell of bitter almonds was disengaged, I immersed the tube in mercury, and received the gas in a solution of pure potash. The gas was continually absorbed by the potash; but it at length displaced the fluid, and I ceased to expose the Prussian blue to heat.

II. The potash impregnated with gas smelt a little of bitter almonds. I then placed it in a sand bath, and suffered it to evaporate slowly to one half. On cooling I perceived at the bottom of the glass irregular crystals, some of which were foliated, others tabular, and some seemed to be cubic. These crystals I separated from the fluid. They exercised a complete reaction, like prussiate of potash on sulphate and nitrate of iron,—only that the precipitate was greenish blue, and became of a beautiful blue only by the addition of acid after a part of it had been dissolved.

III. The liquid separated from the salt was decomposed with a little alcohol, and there was produced a white tender precipitate, which I again separated by the filter. The quantity, however, was so small that scarcely any trace of it remained on the paper.

* From Neues *Allgemeines Journal der Chemie von Hermbstadt, &c.* vol. i. no. 6.

† Scheele's Schriften, vol. ii. p. 342.

 IV. The

IV. The liquor which passed through had in the course of a few hours, and this perhaps would have been the case sooner had I left it at rest, deposited at the bottom an oil which appeared yellowish, and which could not be mixed by shaking it with the supernatant liquor. I suffered it to stand till the next day, in order that I might make more accurate observations in the day-time; but saw with astonishment that the oil had disappeared, and had left in its place a crystalline precipitate, which, though small, exhibited all the phænomena of prussiate of potash. I here suspended all further research, as I was not able to repeat the experiment with sufficient accuracy, and therefore reserved it for further examination. It was, however, established by the first and second experiments, that by this process prussiate of potash, free from iron, can be produced. But if carbonic acid was combined with the prussic acid, an idea I was led to take up by the difference of the crystals which were produced, and by the greenish blue precipitate, it is natural to suppose that the latter expelled the former in part, and mixed also with a part of the potash; and, therefore, the prussiate of potash must have been separated from the prussic acid.

Berthollet's experiment, in which he treated prussic acid with oxygenated muriatic acid, was here of importance*. The prussic acid was decomposed, and an oil was produced: the oil in water sank to the bottom: it no longer reacted like the prussic acid on combinations of iron: it was not inflammable: it evaporated in heat, and in course of time was converted into small crystals. If I entertained any doubts in regard to my own experiments, this coincidence in some manner removed them. The same phænomenon was confirmed by an experiment of a quite different kind, where an oil was produced by the action of alcohol on the prussic acid and carbonate of potash. The confirmation of Berthollet's experiment affords cause for more accurate research in regard to the fundamental mixture of prussic acid, oil, and alcohol.

It still remains to be examined, whether the oil produced in this manner, according to my experiment, was prussic acid. It was possible that the crystals produced might have been again taken up by the fluid, and even by the air, which in my experiments was quite filled with it. Whether the oily fluid produced was really an oil, I was not further able to determine; but by shaking it with the watery fluid

* Crell's Annalen, 1790, vol. i. p. 186.

I divided

I divided it like oil into small globules, which again soon united.

I must here mention another phænomenon, which I cannot pass over with indifference. Every time I heated, for a considerable time, the Prussian blue of the shops over a spirit lamp, in order to prepare the gas, so that the Prussian blue was pretty well decomposed, and had become brownish black, I observed, when the glass was broken, still hot, that the Prussian blue here and there inflamed in the same manner as pyrophorus prepared from alum and charcoal, or like sulphate of potash and charcoal, but without a blue flame. The Prussian blue was always heated over a spirit lamp, so that it was impossible an inflammation could arise. Three or four experiments, repeated for this purpose, confirmed this observation, but I was obliged to break the glass while hot. The same thing did not take place with prussiate of iron, but I made the experiment only once.

The production of pyrophorus by this process may be explained in the following manner:—The Prussian blue of the shops contains, as is well known, argillaceous earth (potash) and a little sulphuric acid: now, as the prussic acid and carbonic acid are disengaged, a decomposition of the sulphuric acid may take place; the sulphur which is produced may unite with the free argillaceous earth; and in this manner we may be conducted to the well known theory of pyrophorus. If this explanation be not agreeable to nature, we have perhaps still obtained more. In my experiments a partial decomposition only took place each time, as only some particles, and those of the largest size, inflamed. This observation might conduct us to the nature of the substance which in this case is the agent, and these experiments may perhaps furnish abler chemists with matter for future research.

XXIV. *Experiments on the Oil produced from the Leaves of the Laurel Cherry.* By C. Roloff *of Magdeburg**.

I have made some experiments with the distilled oil of the leaves of the laurel cherry, the result of which I here communicate, because they are different from that of the experiments of M. Bucholz with distilled oil of bitter almonds.

As M. Bucholz employed potash with success for the

* From the same work as the preceding article.

separation

separation of the radical of the prussic acid from the before mentioned oil, I made choice of lime in order to examine whether earths could be employed for the same purpose, as I believed, and I made the following experiments:

I. I shook for some time half an ounce of fresh prepared lime water, with three drops of the oil of the laurel cherry, by which means a complete mixture of both was effected, and no oil floated at the surface. To this mixture I added half a dram of clear liquid muriate of iron, by which a greenish precipitate, inclining to blue, was produced. When mixed with a sufficient quantity of the muriate, the greater part of the precipitate was redissolved, and the liquid assumed a green colour. After a short time a small quantity of a blue precipitate was deposited, which when filtered, washed, and dried, amounted to nearly half a grain, and exhibited all the appearances of prussiate of iron.

II. I repeated the above experiment, only with this difference, that I employed six drops of oil. The same phænomena were produced, and the blue precipitate at length obtained corresponded perfectly in weight with that of the first experiment, for it amounted to nearly a grain.

By this experiment it is also proved that the distilled oil of the leaves of the laurel cherry forms, by means of lime, prussic acid. I must here remark that, for the greater certainty, I repeated both experiments, as I did in regard to all the rest, without shaking the oil of the laurel cherry, with lime water, by which means I obtained a clear fluid. This I mixed with a drop of the solution of prussiate of potash, by which I produced the same shade of colour in the fluid as in the preceding experiments, and after a little rest a blue precipitate deposited itself at the bottom.

As M. Bucholz did not succeed completely in producing prussiate of iron, by treating the distilled oil of bitter almonds with ammonia, I resolved to repeat the same experiment with the oil of the leaves of the laurel cherry.

III. With this view I shook six drops of this oil with a dram of pure fluid ammonia, and mixed with them half a dram of clear deliquescent muriate of iron, which was still diluted with two drams of distilled water. The result was a green precipitate, mixed with a great deal of blue, which, by the addition of pure muriatic acid, left a blue precipitate, which when washed and dried amounted to a grain, and exhibited all the phænomena of prussiate of iron.

By this also it is proved that ammonia is in no manner prejudicial to the formation of the prussiate of iron, as M. Bucholz concludes from his experiments. The reason

why

why this accurate chemist obtained so few traces of prussiate of iron, no doubt was, that the oil of bitter almonds contains less of the radical of the prussic acid than that of the leaves of the laurel cherry*.

I am also of opinion that the prussic acid does not exist as such in a free state, and with alkalies and earths can form no prussic acid salts without a portion of the oxide of iron. To confirm this opinion I made the following experiments:

IV. Six drops of the oil of the laurel cherry being shaken with half an ounce of lime water, ten grains of acetite of copper dissolved in a dram of distilled water were mixed with it, which produced a green precipitate. This precipitate was again perfectly dissolved by the addition of the acetous acid.

V. I repeated the same experiment, with this variation, that instead of lime water I employed ammonia, by which I obtained the same result.

These experiments, in my opinion, confirm in a complete manner that the prussic acid cannot exist as such without a portion of the oxide of iron; otherwise a reddish brown precipitate, according to analogy, must in these experiments have been produced. Want of oil prevented me from carrying my experiments further.

XXV. *On the Ether suggested by Sir* Isaac Newton, *compared with the supposed newly discovered Principle of Galvanism. By Governor* Pownall †.

Although at an advanced period of life the mind does not possess strength sufficient for the pursuit of *any new research*, or for the study of *any new branch of science*, of which I am conscious as I ought to be; yet feeling myself capable to follow the researches of others, and to judge of their theories when formed, I have in all humble diffidence followed the experiments, and attended to the theories, which modern philosophers have made and formed respecting the phænomena of a supposed newly discovered principle;

* In two experiments with ammonia and the oil of the leaves of the laurel cherry, made by a process different from that of M. Bucholz, I was not able to obtain prussiate of iron; I however have no doubt that this might be effected.

† Communicated by the author.

ciple, which, from the name of the first studying observer, has been called galvanism.

Whilst thus following the phænomena as exhibited in the experiments of these philosophers, by which this supposed newly-discovered agent acts and operates impulsively and chemically in, on, and by various substances, metals, semimetals, minerals, mineralic and other solutions; on water, glass, resins, animal motion and senses, fungic and vegetable substances; I was rather disappointed to find, (under the present advanced state of science) that these experimentalists were at first so disposed to imagine, or so willing to have it imagined, that they had severally made discoveries of some hitherto secret principles in nature, or that they referred to unknown causes operating thereby. On further more scientific investigation, however, by such accurate philosophers as Volta, Dumas, and especially Dr. Wollaston, they simplified the results of their experiments, and have in general agreed to refer all the phænomena of this supposed newly discovered principle, to an agent long known by the name of electricity. Yet I cannot but wish that philosophy had not stopped here; for I own that I cannot conceive this electric agent to be a prime principle *sui generis*, but only a species of operation, classing with all the rest under a more simple and general principle, becoming, by its various modes of cooperation, under various circumstances, a *formal* or perhaps an efficient cause common to all. Instead, therefore, of being led to a plurality of principles and causes, as superficial theologists have been, by the various operations of divine agency, to a plurality of gods, where they ought to have found the true ONE, I keep an eye fixed on a one general principle, which I have been used to acknowledge, as investigated and announced by Sir Isaac Newton, so far as to substantiate its existence. The principle I mean, as known to exist really, but which requires further investigation to ascertain, by its nature and operation, how far it may be a general efficient cause, is that elastic active medium which Newton named ether—" iste æther (id enim ei nomen quid ni imponam, quid sit non definio) quoddam medium longe longeque rarius et subtilius quam aër vel lumen, longeque etiam magis elasticum et actuosum" —" quod corpora omnia facillime permeat, perque cœlos universos vi suâ elasticâ diffusum est." The existence of this principle may be taken as a datum, as a known fact; and so far as concerns the phænomena of its operations, Sir Isaac Newton states, that

that by its compressed elasticity, and its vibrations, it appears to attend and cooperate in all the known operations of nature; in gravity; in attraction of aggregation, and in all the chemical interchanges therein; in repulsion; in the various movements of light, as its direction goes in right lines; in its inflections, its refractions, and reflections; in its fits of easy transmission and reflexion; in heat and light; in magnetism *; in electricity, and in that species of electric attraction †, " quæ tam angustis finibus continetur ut *usque ad huc* omnem observationem fugerit: et fortassè attractio electrica ad istius modi exigua intervalla extendi potest, *etiamsi non excitetur frictione.*" This appears specifically to distinguish that electric operation which has course given to it, by the simple contact of metallic and other substances, without being excited by friction, as vitreous and resinous electricity is. This ether, by its compressed elasticity, or by its vibrations, appears to attend or cooperate in the sense of sight and hearing, and in animal motion ‡.

It evidently appears that Sir Isaac Newton had investigated the nature of this ether, so far as to substantiate long ago its existence, and its operations as a cooperating *formal* cause, so as to recommend it to investigation how far it may be found to be *an efficient cause,* general to all the phænomena therein referred to by him. Although he stated this his information, merely as matters of inquiry, to be pursued by others, yet these phænomena, and the operations whence they arise, have been but lately submitted to experiment; and that with a view and in a line referring to supposed newly discovered principles in nature, and to unknown causes therein.

Here I would wish to recommend the opinion and the words of Professor Cotes to such of the late philosophers who have these views §—" ad veram philosophiam pertinet

* There is a peculiar phænomenon, different from all others, by which this principle acts or is acted upon. It appears to be connected with some agent external to it, by which it acquires and maintains a direction to the north pole of our globe; but yet, whatever be this cooperating agent, whose current gives this specific tendency to the magnet or magnetic needle, this tendency, so far as relates to the magnetic body itself, can be reversed in the body itself, as the current of the power which actuates the voltaic pile can, by an alteration in the position of its parts, be reversed. It is known that the magnetic needle, on being stricken with lightning, has been reversed; and the artificial magnet can have its poles reversed by the same means by which it was first made a magnet.

† Newtoni Opt. quære 31. at the time in which Newton speaks.

‡ Quære 23 et 24.

§ Præfatio ad Newtoni Principia.

rerum

rerum naturas ex vere existentibus causis derivare—in horologiis automatis idem indicis horarii motas vel ab appenso pondere vel ab intùs concluso elatere oriri potest. Quod si oblatum horologium reverà sit instructum pondere; videbitur qui fingit elaterem, et ex hypothesi sic præproperè confictâ, motum indicis explicare suscipiet."

In what I have stated above, I have, perhaps presumptuously towards better philosophers and wiser men than myself, perhaps from inexperience in the present advanced state of science, ventured to express a wish that a course of experiments were instituted to investigate the nature and operations of this ether, a principle known to exist; how far and in what manner it acts; how, if at all, it operates, by its compressed elasticity, in becoming a *cooperating* or an *efficient* cause to gravity and attraction; how far and in what manner it may, by its active movement and its vibrations, cooperate with or be a cause to the phænomena of heat, light, electricity, and all the attractions of natural or chemical affinity, and of the various interchanges therein; and how far, and in what manner, in animal sensations and motion; how far, and in company with what power, it may give to magnetism a polar course. I have ventured, perhaps hazarding my prudence, to recall the study of philosophy to these pursuits in the very line which Sir Isaac Newton so long ago marked out—but which yet, from some suspended doubts about this ether and its existence, have been, as seems to me, neglected and passed by.

XXVI. *On the Preparation, Culture, and Use of the Orchis Root.* *By* J. Percival, *M. D.**

Salep is a preparation of the root of Orchis, or Dogstones, of which many species are enumerated by botanical writers. The *Orchis mascula Linn. Sp. pl.* is the most valued, although the roots of some of the palmated sorts, particularly of the *Orchis latifolia*, are found to answer almost equally well. This plant flourishes in various parts of Europe and Asia, and grows in our country spontaneously, and in great abundance. It is assiduously cultivated in the East; and the root of it forms a considerable part of the diet of the inhabitants of Turkey, Persia, and Syria. A dry and not very fertile soil is best adapted to its growth. An ingenious friend of mine, in order to collect the seed,

* From Hunter's Georgical Essays.

trans-

transplanted a number of the orchises into a meadow, where he had prepared a bed well manured for their reception. The next spring few of them appeared, and not one came to maturity, their roots being black and half rotten. The same gentleman informed me that he had never been able to raise any plants from the seed of the wild orchis; but he ascribes his want of success to the wetness of the situation in which he resides. I have now before me a seed pod of the orchis, the contents of which, to the naked eye, seem to be seed corrupted and turned to dust; but, when viewed through a microscope, appear evidently to be organized, and would, I doubt not, with proper culture, germinate, and produce a thriving crop of plants. The properest time for gathering the roots is when the seed is formed, and the stalk is ready to fall, because the new bulb, of which the salep is made, is then arrived to its full maturity, and may be distinguished from the old one by a white bud rising from the top of it, which is the germ of the orchis of the succeeding year.

Several methods of preparing salep have been proposed and practised. Geoffroy has delivered a very judicious process, for this purpose, in the *Histoire de l'Académie Royale des Sciences*, 1740; and Retzius, in the Swedish Transactions, 1764, has improved Geoffroy's method. But Mr. Moult, of Rochdale, has lately favoured the public with a new manner of curing the orchis root: and as I have seen many specimens of his salep, at least equal, if not superior, to any brought from the Levant, I can recommend the following, which is his process, from my own knowledge of its success: The new root is to be washed in water, and the fine brown skin which covers it is to be separated by means of a small brush, or by dipping the root in hot water, and rubbing it with a coarse linen cloth. When a sufficient number of roots have been thus cleaned, they are to be spread on a tin plate, and placed in an oven heated to the usual degree, where they are to remain six or ten minutes, in which time they will have lost their milky whiteness, and acquired a transparency like horn, without any diminution of bulk. Being arrived at this state, they are to be removed, in order to dry and harden in the air, which will require several days to effect; or, by using a very gentle heat, they may be finished in a few hours*.

Salep, thus prepared, may be afforded, in this part of

* Vide a Letter from Mr. John Moult to the author, containing a new method of preparing salep, in Phil. Transact. vol. lix.

England,

England, where labour bears a high value, at about 8d. or 10d. per lb. And it might be sold still cheaper, if the orchis were to be cured without separating from it the brown skin which covers it; a troublesome part of the process, and which does not contribute to render the root either more palatable or salutary. Whereas the foreign salep is now sold at 5s. or 6s. per lb.

The culture of the orchis, therefore, is an object highly deserving of encouragement from all the lovers of agriculture. And as the root, if introduced into common use, would furnish a cheap, wholesome, and most nutritious article of diet, the growth of it would be sufficiently profitable to the farmer.

Salep is said to contain the greatest quantity of vegetable nourishment in the smallest bulk. Hence a very judicious writer, to prevent the dreadful calamity of famine at sea, has lately proposed that the powder of it should constitute part of the provisions of every ship's company. This powder and portable soup, dissolved in boiling water, form a rich thick jelly, capable of supporting life for a considerable length of time. An ounce of each of these articles, with two quarts of boiling water, will be sufficient subsistence for a man a day *; and, as being a mixture of animal and vegetable food, must prove more nourishing than double the quantity of rice cake, made by boiling rice in water. This last, however, sailors are often obliged solely to subsist upon for several months, especially in voyages to Guinea, when the bread and flour are exhausted, and the beef and pork, having been salted in hot countries, are become unfit for use †.

But, as a wholesome nourishment, rice is much inferior to salep. I digested several alimentary mixtures prepared of mutton and water, beat up with bread, sea-biscuit, salep, rice flour, sago powder, potatoe, old cheese, &c. in a heat equal to that of the human body. In forty-eight hours they had all acquired a vinous smell, and were in brisk fermentation, except the mixture with rice, which did not emit many air bubbles, and was but little changed. The third day several of the mixtures were sweet, and continued to ferment; others had lost their intestine motion, and were sour; but the one which contained the rice was become

* Portable soup is sold at 2s. 6d. per lb.; salep, if cultivated in our own country, might be afforded at 10d. per lb.: the day's subsistence would therefore amount only to twopence-halfpenny.

† Vide Dr. Lind's Appendix to his Essay on the Diseases of Hot Climates.

putrid.

putrid. From this experiment it appears that rice, as an aliment, is slow of fermentation, and a very weak corrector of putrefaction. It is therefore an improper diet for hospital patients; but more particularly for sailors in long voyages, because it is incapable of preventing, and will not contribute much to check the progress of that fatal disease, the sea-scurvy *. Under certain circumstances rice seems disposed of itself, without mixture, to become putrid; for by long keeping it sometimes acquires an offensive fœtor; nor can it be considered as a very nutritive kind of food, on account of its difficult solubility in the stomach. Experience confirms the truth of this conclusion: for it is observed by the planters in the West Indies, That the negroes grow thin, and are less able to work whilst they subsist upon rice.

Salep has the singular property of concealing the taste of salt water †; a circumstance of the highest importance at sea, when there is a scarcity of fresh water. I dissolved a drachm and half of common salt in a pint of the mucilage of salep, so liquid as to be potable, and the same quantity in a pint of spring water. The salep was by no means disagreeable to the taste, but the water was rendered extremely unpalatable.

This experiment suggested to me the trial of the orchis root as a corrector of acidity; a property which would render it a very useful diet for children. But the solution of it, when mixed with vinegar, seemed only to dilute, like an equal proportion of water, and not to cover its sharpness.

Salep, however, appears by my experiments, to retard the acetous fermentation of milk, and consequently would be a good lithing for milk pottage, especially in large towns, where the cattle, being fed upon sour draff, must yield acescent milk.

Salep in a certain proportion, which I have not yet been able to ascertain, would be a very useful and profitable addition to bread. I directed one ounce of the powder to be dissolved in a quart of water, and the mucilage to be mixed

* Cheese is now become a considerable article of ship provisions. When mellowed by age, it ferments readily with flesh and water, but separates a rancid oil, which seems incapable of any further change, and must, as a septic, be pernicious in the scurvy; for rancidity appears to be a species of putrefaction. The same objection may be urged, with still greater propriety, against the use of cheese in hospitals; because convalescents are so liable to relapses, that the slightest error of diet may occasion them. Vide Percival's Letter to Mr. Aikin.—Thoughts on Hospitals, p. 95.

† Vide Dr. Lind's Appendix.

with a sufficient quantity of flour, salt, and yeast. The flour amounted to two pounds, the yeast to two ounces, and the salt to eighty grains. The loaf, when baked, was remarkably well fermented, and weighed three pounds two ounces. Another loaf, made with the same quantity of flour, &c. weighed two pounds and twelve ounces: from which it appears that the salep, though used in so small a proportion, increased the gravity of the loaf six ounces, by absorbing and retaining more water than the flour alone was capable of. Half a pound of flour and an ounce of salep were mixed together, and the water added according to the usual method of preparing bread. The loaf, when baked, weighed thirteen ounces and a half; and would probably have been heavier if the salep had been previously dissolved in about a pint of water. But it should be remarked, that the quantity of flour used in this trial was not sufficient to conceal the peculiar taste of the salep.

The restorative, mucilaginous, and demulcent qualities of the orchis root render it of considerable use in various diseases. In the sea-scurvy it powerfully obtunds the acrimony of the fluids, and at the same time is easily assimulated into a mild and nutricious chyle. In diarrhœas and the dysentery it is highly serviceable, by sheathing the internal coat of the intestines, by abating irritation, and gently correcting putrefaction. In the symptomatic fever, which arises from the absorption of pus, from ulcers in the lungs, from wounds, or from amputation, salep, used plentifully, is an admirable demulcent, and well adapted to resist that dissolution of the crasis of the blood which is so evident in these cases. And, by the same mucilaginous quality, it is equally efficacious in the strangury and dysury; especially in the latter, when arising from a venereal cause; because the discharge of urine is then attended with the most exquisite pain, from the ulcerations about the neck of the bladder, and through the course of the urethra. I have found it also an useful aliment for patients who labour under the stone or gravel *.

From

* The ancient chemists seem to have entertained a very high opinion of the virtues of the orchis root, of which the following quotation, from the SECRETA SECRETORUM of Raymund Lully, affords a diverting proof. The work is dated 1565.

SEXTA HERBA.

Satirion.

" Satirion herba est pluribus nota, hujus radicis collecta ad pondus lib. 4. die 20 mensis Januarii, contunde fortiter et massam contusam pone in ollam

From these observations, short and imperfect as they are, I hope it will sufficiently appear that the culture of the orchis root is an object of considerable importance to the public, and highly worthy of encouragement from all the patrons of agriculture. That taste for experiment which characterizes the present age, and which has so amazingly enlarged the boundaries of science, now animates the rational farmer, who fears not to deviate from the beaten tract whenever improvements are suggested, or useful projects pointed out to him. Much has been already done for the advancement of agriculture; but the earth still teems with treasures which remain to be explored. The bounties of nature are inexhaustible, and will for ever employ the art and reward the industry of man.

XXVII. *On the Plants employed by the antient People of Europe for Poisoning their Arrows. By* C. COQUEBERT*.

ALL those nations who live by hunting have sought, in the vegetable kingdom, for active poisons in which they might dip their arrows, in order to kill with the greater certainty the animals they employed as food.

Most historians have neglected to make known to us the plants used for this purpose by our ancestors, the half savage inhabitants of Europe, in the most remote periods. Chance, however, put into my hands two Spanish works, in which I found some passages which throw light on this interesting subject.

The title of the first of these works is *Synopsis Stirpium indigenarum Arragoniæ*, published in 1779, the author of which, a native of Saragossa, denotes himself by the initials C. A. R. This author quotes a manuscript of Cienfuegos, his countryman, who wrote about 1518 on the botany of Arragon, who relates that in his time the Spanish hunters were still accustomed to poison their arrows, and that the poison in which they dipped them was so powerful, that if an animal was in the least wounded the hunter was sure of his prey. The vegetable from which they pre-

ollam de aurichalco habente in cooperculo 20 foramina minuta sicut athomi, et pone intus eo prædicta messá lactis vaccini calidi sicut mulgetur de vacca lb. 3. et mellis libram 1. vini aromatici lb. 2. et repone per dies 20. ad solem et conserva et utere.

"Istius itaq; dosis ad pondus 3. 4. et hora diei decima exhibita mulieri post ipsius menstrua eadem nocte concipiet si vir cum ea agat."

* From *Bibliothèque Physico-economique*, an vi.

pared

pared it was the *Veratrum album*, white hellebore, a plant very common in the pasture lands of the alpine mountains. To prepare the poison, however, for this purpose required some dexterity. Cienfuegos adds, that in his time the king of Spain had a huntsman who understood it thoroughly.

The second work from which I have derived information on this subject is the History of the War of Grenada under Philip II., by Mendoza. This author, so highly esteemed by the Spaniards for the purity of his style, his impartiality, and the extent of his learning, says, that the poison which the hunters of his country employed at the time he wrote, that is at the beginning of the seventeenth century, was prepared in the mountains of Bejar and Guadarrama, and was called in that part of Spain *El zumo de vedegambre*. It was formed into an extract of a reddish brown colour. Another indigenous poisonous plant, which the inhabitants called *Yerva*, that is to say "the herb," by way of excellence, was employed for the same purpose in the high mountains of Grenada: it is the *Aconitum lycoctonum*, or wolf's-bane, which, like the *Veratrum*, grows on the high mountains. The effects produced on the animals wounded by poisoned arrows are, according to Mendoza, the same, whether hellebore or wolf's-bane be employed. They both consist in sudden and great debility, coldness, numbness, and cecity: they foam at the mouth, and are thrown into a state of convulsion. Mendoza says, that two plants, which he indicates only by the Spanish names of *Membrillo* and *Retama*, with the meaning of which I am not acquainted, were employed as antidotes.

After I had seen these passages, I was desirous of examining what Haller says of the plants mentioned in his *Historia Stirpium indigenarum Helvetiæ*, or rather in the French translation which Vicat has given of the part which relates to the properties of plants.

"If it happens," says he, "that the poison of the *Veratrum* penetrates to the blood, without having lost any of its force, death immediately ensues, even though introduced by a slight wound: this has been observed when the antient Portuguese were accustomed to poison their arrows with the juice of that plant." This observation was confirmed by the experiments of Matthioli. When death takes place in this manner, putrefaction makes so rapid a progress that the flesh of the animal becomes tender as soon as it ceases to breathe. Guilandinus speaks also of the poison which the Spaniards prepared from this plant.

Two

Two drachms of a decoction of the root of the *Veratrum* injected into the veins of an animal, throw it immediately into convulsions, and produce vomiting followed by death, and almost at the same moment a state of flaccidity.

A spirituous infusion, according to Haller, has more strength than an aqueous, and the latter more than a decoction or an extract. There is reason to believe that the activity of this plant resides in the volatile parts which the boiling disengages.

Under the article black hellebore, *Helleborus viridis* of Linnæus, Haller says also that this plant serves to poison arrows; and he quotes Monardus, who relates that a chicken died in consequence of a fibre of black hellebore being made to pass through its crest. So deleterious an action, however, can hardly be allowed to this hellebore, since in the time of Columella the root of it was employed to make setons for cattle, which were made to pass through the skin, and particularly of the neck, and thereby excited suppuration.

In regard to wolf's-bane, the following observation, on that species called by Linnæus *Aconitum cummarum*, occurs in the work of Haller:—The juice of this plant having been accidentally introduced into a wound, in a very small quantity, it produced cardialgia, syncope, swelling, and at length gangrene of the arm.

It appears from these facts, that the three plants above mentioned, but chiefly the *Veratrum*, were those employed by the antient inhabitants of Europe for poisoning their arrows; and that the introduction of fire-arms made them gradually abandon the use of this poison, which was still employed by the Spaniards in the seventeenth century.

XXVIII. *Experiment showing the Advantage of Periscopic Spectacles. By* W. H. Wollaston, *M.D. F.R.S.*

To Mr. Tilloch.

SIR,

The opinion given by Mr. Jones, in your last Magazine, respecting the improved form of spectacle-glasses, on which I had delivered my sentiments in the preceding number (p. 327), induces me to trouble you once more upon that subject.

It is wholly unnecessary to make any reply to the vari-

ous observations of Mr. Jones, or to remark upon the experiment by which he has deceived himself, because all doubt of the advantage of the periscopic glasses may be removed by the following direct comparative trial, which any person who chooses can repeat without difficulty.

I have before me two glasses, each of 4 inches "positive focus," as proposed by Mr. Jones, the one double convex, which in his judgment is pronounced to be "*indubitably the best and most convenient that can be devised,*" the other a concavo-convex, or meniscus, which he thinks "*evidently the worst of the two for a spectacle-glass.*"

When I fix the former at the distance for most distinct vision opposite to a printed octavo page, and approach my eye to the glass, I cannot without pain read quite 24 lines; but upon substituting the periscopic glass, fixed in the same position, I can discern every word in the page, which contains 40 lines.

The enlargement of the field of view observable in this trial, is sufficient to evince the superior utility of the periscopic glasses; but were there occasion to compare more nearly the circular surfaces that may be seen with equal distinctness by each, they would be found to differ by a ratio as great as that of three to one.

The difference is of course more evident in glasses of so high power, than in those used by most long-sighted persons for common purposes; but it cannot be doubted that in the latter also a corresponding, though smaller, inequality subsists, wherever there is the same dissimilarity of construction, even when the focal distance is longest.

The advantage in question is, therefore, indisputably proved by direct experiment; to the novelty also Mr. Jones himself has unintentionally contributed very satisfactory evidence; but as to its importance, those only who have the misfortune to labour under any defect of vision must ultimately decide.

I remain, Sir,

Your obliged humble servant,

March 30, 1804. W. H. Wollaston.

XXIX. *Process*

XXIX. *Process for extracting the Salt, with a Base of Lime, contained in Yellow Cinchona. Communicated to* M. Fourcroy *by* C. Deschamps, *of Lyons**.

Take twelve pounds of yellow cinchona, of a good quality, pounded, and sifted through a hair sieve †. Put it into a large pitcher with a beak, and pour over it fifty French pints of pure cold water. Suffer it to macerate for twenty-four hours, taking care to stir it several times in the course of the day. Decant it next morning, pouring the liquor, which has been left to form a deposit during the night, through a close sieve made of goats' hair. Then pour this and the following infusions into vessels, which must be preserved in a cool place:

Pour over the remaining matter, after the moisture has been suffered to drain off, thirty French pints of cold water. Leave it to infuse for twenty-four hours, stirring it as before; then decant the liquor, and pour over the matter, when well drained, twenty pints of cold water, which makes the whole of the water to be 100 pints.

At the end of twelve hours' maceration, squeeze the matter in a press; then filter all these infusions united, and put them to evaporate in a large broad bason of silver, or of tinned copper. Maintain the evaporation by a gentle heat, that the liquor may not approach the degree of ebullition; and when reduced nearly to a half, pour it into a vessel and leave it till it is perfectly cold; then filter it, and wash several times by pouring water almost cold through the filter the deposit which has been left upon it.

Unite these lotions to the filtered liquor, and continue the evaporation in a smaller vessel until it be reduced six or seven pints. Then leave it to cool, filter it again and wash the resino-mucous matter as before, until the last portions furnish very little precipitate by the addition of carbonate of potash.

* From the *Annales de Chimie*, No. 142.

† The cinchona which I have hitherto employed in preference for extracting this salt was the yellow kind. It furnished it in more abundance, and presented less difficulty in purification than the red and the gray, which I treated also. The quantity which it produced may be estimated at an ounce and three gros per pound of the yellow cinchona employed. This result never varied in the specimens I used. The weight of the cinchona I employed was at least twelve pounds. The loss by this quantity was less than if I had operated with a smaller quantity; the crystals, besides, were larger and more distinct.

Continue this evaporation, filtration, and washing, until the liquor, by means of a gentle heat, has been brought to half the consistence of syrup. Then pour the liquid into a vessel of earthen ware *, which must be deposited in a cool place and left at rest for a fortnight.

At the end of that time pour off, by inclining the vessel, the condensed liquor, which will float over the crystals that have been formed. Wash them with a sufficient quantity of water, rubbing them gently with a small soft brush, or the barb of a quill, in order to free them from the thick extract which adheres to them.

After this washing, detach the crystals, removing as little as possible the resino-extractive matter to which they are often fixed in this first crystallization †. Pound the salt and dissolve it, triturating it several times in a sufficient quantity of cold water. Filter these solutions, including the liquor which arises from the washing of the crystals, and evaporate the whole to the consistence proper for crystallization ‡.

By this first purification you will obtain crystals very little coloured, and much less mixed with substances foreign to the salt. If you wish to obtain them of a greater degree of purity, you must proceed to a second purification in the following manner:

After having washed and detached the crystals, dissolve them cold as before; filter the liquid, wash the deposit, and reduce the whole by slow evaporation to the proper degree.

The salt obtained will be exceedingly beautiful and perfectly pure. Its crystals are formed of laminæ truncated

* For these crystallizations I prefer flat dishes to those which are conical.

† If care has been taken to filter the liquor several times, according as it is concentrated, and always after it has been suffered to cool, it will be so much freed from the resino-gummy part, that after the first crystallization, though the saline mass will still be of a russet colour, the base of the crystals will be free from that matter which it was my chief object to remove.

The small portion of salt which I had the pleasure of sending to you arose from the first crystallization alone. When the infusion was reduced to six or seven pints, I took care in the course of the subsequent evaporation to filter it cold at three different times. By pursuing this course, very little matter adheres to the saline crust, and the supernatant extractive matter can be separated with the greater facility.

‡ The more I advanced in the purification of my salt, the less I thickened the liquor: the degree of concentration must be proportioned to the quantity of extractive or resino-mucous matter it may have contained. It is not easy to hit this point.

at

at their extremity and applied obliquely to each other: I propose to call it *cinchonate of lime.*

I have several times obtained in the crystallized mass a different disposition; which struck me the more, as it is not often found, namely, in groups, perfectly round and regular in the divergency of the laminæ of which they are composed. They are in a manner insulated, and each of them exhibits a summit which hangs over the plane surface of the other crystals. This variation in the assemblage took place only in the first crystallizations: I never observed it in those which produced the purified salt.

The process here indicated is not sufficient, as may readily be conceived, to extract from cinchona the whole of the salt it is capable of furnishing. The thick liquor which floated over the first crystallization, and which has been laid aside, still contains a great deal of it. To obtain it, the extractive matter must be freed as much as possible from the other two immediate materials of cinchona which oppose most the separation of the saline substance, the resin and the mucous matter, which are extracted separately or combined.

For this purpose, when I wished to ascertain in the most precise manner the quantity of this salt which yellow cinchona might contain, confining myself always to water as an agent, I treated, cold, this compound extract, as indicated for the purification of the first product, and repeating the dilution, filtration, and evaporation, I found means to insulate, in a manner, the extract of cinchona, which when thus treated retains scarcely any thing but the mucous part.

When the saline liquor, thus purified, refused to furnish crystals, I united it to that which floated over the salt carried to the highest degree of purity, mentioned in the first article of this process. This mixture still furnished me with abundance, and in the last result the liquor I abandoned had still such a saline appearance as to give me reason to expect something more to add to my recapitulation of its contents. On examination I found nothing but products similar to those which I obtained from the decomposition of the crystallized salt. The matter which I precipitated is absolutely of the same nature; it is only more coloured in proportion to the resino-extractive matter it contains.

The means which I have here described are attended with considerable embarrassment, and require a good deal of time and expense, which no doubt might be avoided by treating the bark differently. I have several times thought, that by employing

employing fewer lotions, infusions, &c., I should obtain a less quantity of salt, but that, as this would change nothing in the nature of the product, I should find it more advantageous.

Having in the first place proceeded to an analysis, and wishing that as little of the salt as possible should escape me, I conducted the process in a rigorous manner; and since that time I have practised the same manipulation.

There is reason, however, to think that the operation might be much shortened by the help of alcohol: as this fluid has no action on the calcareous salt of cinchona, it might be employed two ways to remove the resin, which forms the greatest obstacle to the extraction of this saline substance, either by subjecting the cinchona in its natural state to the alcohol before proceeding to aqueous infusion, or by exposing to its action the extractive matter which results from the concentration of the first infusions.

XXX. *On Galvanism. By a Correspondent.*

To Mr. Tilloch.

SIR,

NOT having seen or heard any satisfactory hypothesis concerning the increased effect produced by the Galvanic battery upon animals by increasing the number of plates, and upon metals by enlarging their surface, I beg, through your valuable miscellany, to call the attention of Mr. Davy and other philosophers to the subject; and shall be happy to receive, through the same channel, an explanation of these apparently inconsistent phænomena.

It is well known that the effect on animal bodies is proportionate to the series or number of plates of which the battery is composed, and that on metals it increases with the area or surface of the plates employed. The fact is attempted to be accounted for upon the supposition that the skin, from being an imperfect conductor, is capable of transmitting only a certain portion of Galvanic fluid, and that metals, being perfect conductors, can transmit any indefinitely larger quantity. But this theory, although it may be supported by experiment when *equal numbers* of small and large plates are employed, does not appear to me to account for the phænomena when *different numbers* of plates of *equal sizes* are used.

I conceive

I conceive the following propositions will be admitted as axioms in this science:

1st, The quantity of fluid evolved is proportionate to the quantity of metal oxidated, whether the oxidation of the metal be the mediate or immediate cause of its evolution.

2d, The quantity of metal oxidated is in proportion to the extent of surface exposed to the action of a proportionate quantity of acid. Thus four parts of acid will produce four times as much oxide from an eight-inch plate, as one part would from a plate of four inches.

3d, The fluid evolved is, from the equal attraction of equal portions of the conducting body for equal portions of the fluid, diffused equally over every equal portion of the conducting substances of which the battery is composed, in proportion to the conducting powers of each respectively.

4th, The quantity of fluid transmitted through metallic arcs is measured by the degree of ignition produced.

5th, The intensity of the shock received is the measure of the quantity of fluid transmitted through animals.

Hence it will follow, that from a battery of 25 eight-inch plates, or of 100 of four inches, four times as much fluid will be evolved as from one of 25 four-inch plates, supposing the distance between the plates equal, and the same proportion of acid employed in both cases; or, in other words, the fluid evolved will be as the area of all the plates taken together, and it will be equally diffused over the whole surface of each battery in proportion to the conducting power of its several parts.

Now suppose the skin, from its imperfect conducting power, incapable of transmitting more fluid than is evolved from a battery of 25 four-inch plates, and that this supposition will account for the intensity of the shock not being increased when 25 eight-inch plates are used; so far the fact and theory would agree. But under other circumstances this theory involves contradiction and absurdity. For example, as no difference in the intensity of the shock is perceived, whether 25 four-inch or 25 eight-inch plates be used, the skin cannot transmit more fluid than is given out by 25 four-inch plates.

But the skin will transmit from 100 four-inch plates a greater quantity of fluid than from 25 plates of the same size;

Therefore the greater and lesser quantities are equal: for the skin cannot at the same time have, and not have, the

5 power

power of transmitting any excess of fluid above a given quantity, suppose that produced by 25 four-inch plates.

Some other theory must therefore, it appears to me, be necessarily resorted to. I am, sir,

Your obedient servant,

March 12, 1804. B. E.

XXXI. *Sketch of a Geological Delineation of South America.* *By* F. A. VON HUMBOLDT.

[Concluded from p. 36.]

HAVING already given a cursory view of the general appearance which the mountains of South America exhibit to the eye of the geologist, I shall now enumerate the different kinds of mountains which I have hitherto discovered in that country, beginning with the oldest.

I. *Primitive Mountains.*

Granite.—The whole cordillera of Parima, and particularly the neighbourhood of the volcanoes of Duida and Marcielago, consist of granite, which does not form a transition into gneiss. In the cordillera of the coast it is almost every where covered and mixed with gneiss and micaceous schist. I saw it disposed in strata of from two to three feet in thickness, exceedingly regular, declining from three to four per league, towards the north-west between Valencia and Portocabello. I found it on the Rincon del Diablo south-east from Portocabello, with large and beautiful crystals of feldspar an inch and a half in diameter, like the large grained granite on the high summits of the Schneegebirg and the Fichtelberg, those of Scotland and Chamouni. It is here split into regular prisms; and I saw it on Calavera du Cerro de Mariana beyond Cura, and on the Silla de Caracas, in this prismatic form, which the learned mineralogist M. Karsten observed on the Schneekoppe in Silesia. The northern part of Germany, and the lands on the Baltic in Europe, but not the plain to the south of the Fichtelberg in Swabia and Bavaria, are full of monstrous blocks of granite which have rolled down from the heights. In neither of the llanos of South America, that of Orinoco, and that of the Amazon river, did we find any such masses, and no fragments of primitive mountains. The granite mountains of Los Mariches near Caracas, and those of Torrito between

tween Valencia and St. Carlos, and that of Sierra Neveda de Merida, contain, like that of St. Gothard, fissures which are covered with very beautiful and large rock crystals.

The granite is covered with gneiss and micaceous schist, particularly on the cordillera of the coast of Venezuela. Gneiss is abundant in particular from Cape Chichibocoa to Cape Codera in the Tequez, Cocuiza, and the mountain Guigne, as well as in the islands of the Lake of Valencia, where I found (on Cape Blanc, opposite to Guacara,) blackish quartz in the gneiss which passes into Lydian stone, or rather into the schistous state of Werner. The Macanao on Margaret's island, and the whole cordillera on the isthmus of Cariaco, is nothing else than micaceous schist full of red garnets; and at Maniquarez it is combined with a little cyanite. Green garnets are intermixed with the gneiss of the mountain Avila. In the gneiss of the rock Calamicari in Cassiquiare, and in the granite of Las Trincheras near Valencia, I saw round masses, from three to four inches in diameter, interspersed, which consisted of finer grained granite, yellow feldspar, a great deal of quartz, and scarcely any mica. Is this old granite contained in some of later formation, or are these masses, which have the appearance of accumulations, merely the effect of attraction, which here and there made the particles to approach nearer to each other, but at the same time that the whole mountain was formed? This phænomenon of one kind of granite interspersed in the other is observed also in Silesia, at Wunsiedel, on the Fichtelberg, in Chamouni, on St. Bernard, on the Escurial, and in Galicia. Nature is uniform in her natural productions, even to the small variations in proportions.

The micaceous schist passes into talc schist in the cordillera of the coast, on the mountain Capaya, and on the Quebrada Secca, in the valley del Tuy. In the cordillera of Parima talc is found in very large shining masses, and this has contributed so much to the celebrity of the Dorado, or Cerro Ucucuamo, between the river Esquivo and Mao, in the island Pumacena. The bright fiery appearance exhibited sometimes by the truncated pyramids of the large Cerro Calitamini, near Cunavami, at sun-setting, seems also to proceed from a stratum of talcy schist cut perpendicularly towards the west.

Small idols of nephrite, which I saw brought from Erovato, show that to the south of Raudal de Mura there are nephrite rocks in gneiss like those I found at the bottom of St. Gothard, near Ursern. This formation was repeated by nature

nature in the land of the Tupinambaros Indians. La Condamine discovered this variation of the hard nephrite, which is known under the name of the Amazon stone.

The granite, gneiss, and micaceous schist, contain here, as in Europe, strata of chlorite schist arranged under each other in the sea at Cape Blanc west from Guayra. Very pure and beautiful hornblend schist is found in the streets of Guyana; and, still more south, in the cordillera of Parima, feldspar effloresces into porcelain earth in the Silla de Caracas; strata of quartz, with magnetic iron-stone, is found at the sources of the Cutuche, near Caracas; grained foliaceous, primitive limestone, without tremolite, but with a great deal of sulphureous pyrites and sparry iron-stone, on the Quebrada de Topo on the road from Caracas to Guayra. This limestone is entirely wanting in the cordillera of Parima, where it has been sought for many years. Zeichen schist, a kind of carbonaceous iron, and pretty pure graphite, are found in the Quebrada de Tocume near Chacao, in the Quebrada Secca near Tuy, and north from the Laguna Chica; on the difficult road which leads across the isthmus of Cariaco to Chiparipara, there are found veins of quartz, which contain auriferous sulphureous pyrites and antimony, native gold, gray silver ore, mountain blue, malachite, &c.

The copper ore of Aroa is the only kind here taken from the earth: sixty or seventy slaves obtain yearly 1500 quintals at most of refined copper. The quintal is sold for twelve piastres. The valley in which this ore is dug up is less unhealthful than the valleys near the sea where the Indians wash gold; namely, Urama, Maron, and Alpagoton, where the air appears to be poisonous, as is the case in the fertile valley of Cararinas between Nirgua and Rio Jaracuy. The gold is dispersed throughout the whole province, particularly in the strata of quartz at Baruta, Catia, Guigne, Quebrada del Oro near Tuy, and on the Cerro de Chacao, and Real de Santa Barbara near St. John, where I found barytic spar, the only instance I ever met with in this country. All the rivers of the province of Characas, wash down gold. It however does not thence follow that this province is rich, and contains veins of gold not yet discovered: the gold may be interspersed in whole masses of granite; and I am acquainted with no high granite cordillera, either here or in Europe, the rivers of which do not wash down gold. The Cerro Duida of Esmeralda in Dorado, the Quebrada du Tigre near Encaramada, and the Cerros de Amoco, the Real de S. Barbaro near St. John, the

the Quebrada de Catia, the alum ore of Chuparuparu, some traces of iron ore in the llano of St. Sebastian, and particularly the Aroa abundant in copper, seem to call for the industry of the miners.

Argillaceous schist is very scarce: it covers the micaceous schist on the southern declivity of Venezuela, in the neighbourhood of the Llanos, in the Quebradas de Malparo, and Piedra Azul: there is blue argillaceous schist, with veins of quartz, on the isthmus of Cariaco, near Chuparuparu, in the Distillador Arroyo du Robola, and also on Macanao. In the four last-mentioned places there are found in the argillaceous schist alum and vitriolic schist, in strata of two or three feet in thickness, which effloresce sulphate of alumine, or natural alum, with which the Indians of Guayqueries carry on a little trade.

Serpentine is found on the cordillera of Venezuela above micaceous schist, on the surface of Villa de Cura, at the height of 215 toises; between the Cerro de Piedras Negras and the Rio Tucutunemo, here and there green olivin mixed with glimmer, without garnets, schillerspath, or hornblend, but with veins of bluish lardstone.

Grunstein (green rock), original trapp, an intimate union of hornblend and feldspar, sometimes intermixed with sulphureous pyrites and quartz, often confounded with basaltes, and very little known in Europe, is found in strata of two fathoms in thickness, or balls of from three to four feet in diameter, composed of concentric strata united with micaceous schist or original argillaceous schist, in several places of the northern and southern declivity of the cordillera of the mountain Avila, in the sea near Cape Blanc, in a real vein which traverses the strata of gneiss, but intermixed with newer granite, which fills up the vein between Antimano and Carapa near Caracas. The gray stone contains here red garnets which I have never seen in Europe. I have sent specimens of them to Madrid in the first box which I transmitted to the captain-general of Caracas.

II. *Kind of Mountains which form the Transition from Primitive to Alluvial Mountains. Formation of the Transition of Werner.*

This formation is found in particular to the north of the Parima cordillera, opposite to Caccara, and in large masses on the southern declivity of the Venezuela cordillera. Between the llanos and Morros of S. Juan, between the Villa de Gura and Parapara, between longitude 9° 33′ and 9° 55′, one seems to enter a land of basaltes, on descending from the

the height of 300 to 63 toises above the level of the sea. Every thing reminds one here of the mountains of Bilin in Bohemia, or of Vienza in Italy. The primitive serpentin on the banks of the Tucutunemo, which like that of Silesia contains copper veins, becomes gradually mixed with feldspar and hornblend, and makes the transition into trapp or grunstein. This trapp is found in stratified masses declining 70° towards the north, or in balls with concentric strata, which, interspersed in calcareous clay, form pyramidal hills; sometimes the transition argillaceous schist of Werner is interspersed in green and very heavy argillaceous schist, which consists of hornblend and argillaceous schist intimately mixed together. The same argillaceous schist makes a transition near the Quebrada de Piedras Azules into the primitive argillaceous schist above which it lies. The trapp or grunstein contains also foliaceous olivin, crystallized in pyramids of four faces, a fossil which M. Friesleben discovered on our tour into Bohemia, and described in the Mineralogical Journal of Freyberg, augite with a shelly fracture, leucite in dodecaedra, the sides of the holes and cavities of which are covered with green earth like that of Verona, and a substance which has the splendour of mother-of-pearl, and which I consider as zeolite. All these interspersed fossils increase towards Parapara, and the trapp there forms real amygdalite. Above this amygdalite, near the hill Florez, at the entrance into the large valley of Orinoco, lies that remarkable stone which is scarce in Europe, and which Werner describes under the name of porphyry schist. The hornschist of Charpentier, a kind of rock which accompanies basaltes, forms groups of irregular columns, and by the impression of the ferns which it contains in the middle of the mountains, as discovered by M. Reuss, proves that it is not of volcanic origin. The porphyry schist of Parapara is a green mass of sonorous stone, which is very hard, acute angled, and has transparent fragments on the edges: it strikes fire with steel, and contains vitreous feldspar. I did not expect to find this stone again in South America; it however does not form here such groups of grotesque appearance as in Bohemia, and on mount Eugoneide in the Venetian territories, where I have seen it.

III. *Alluvial Mountains.*

These secondary formations, which are of later origin than the organic bodies of the earth, follow each other in the order of their relative age, as in the plains of Europe,

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and as has been mentioned by that excellent geologist M. Von Buch, in his Mineralogical Description of the County of Glatz in Silesia, a small work, which contains valuable ideas and interesting observations.

I found here two formations of compact limestone. The one makes a transition into the small grained and imperceptibly foliaceous limestone, and is identic with the limestone of the high Alps; the other is compact, exceedingly homogeneous, with several petrifactions of shells, and analogous to the limestone of Jura, Pappenheim, Gibraltar, Verona, Dalmatia, and Suez; a formation of foliaceous gypsum, and another mixed with clay, containing common salt and rock oil. The saline clay which I always found accompanied with rock salt in the Tyrol, Steyermark, and Salzbourg in Swisserland; marl schist stratified in limestone of the Alps, and two formations of sandstone, one of which is older and almost without petrifactions, sometimes small and large-grained sandstone of the llanos, and the other full of the remains of marine animals, which forms the transition into the compact limestone.

The blue limestone of the Alps, with white veins of calcareous spar, is found on the micaceous schist lying upon the Quebrada Secca near Tuy to the east from the Punta Delgada, on the road from Cumana, on the Impossible towards Bordones, on the island of Trinidad, and on the mountain Paria. This limestone contains here, as in Swisserland, three formations arranged under each other:—1st, Repeated strata of black marl schist; marl schist, or cupreous schist of Thuringia, mixed with pyrites, and earth pitch on the Cuchivana near Cumanacoa. This clay contains carbon, and absorbs the oxygen of the atmospheric air. 2d, Saline clay mixed with rock salt and crystallized gypsum, in which the salt pits of Araga, Pozuelas, and Margaret's Island are placed. 3d, Small-grained sandstone, with a calcareous base, almost without petrifactions of shells, always penetrated by water, and sometimes with brown strata of ferruginous earth on the Cocollard, Tamirquiri. I am not certain whether the last-mentioned stone lies on the limestone, or is not sometimes covered by it.

This limestone serves as the base for a newer one. It is exceedingly white and compact, full of holes (Cueva del Guacharo, in which thousands of birds reside, and among which is a new genus of Caprimulgus, from which a kind of fat much used in the country is obtained, Cueva del S. Juan, Cueva del Cuchivano); sometimes porous like the Franconian, and forms grotesque rocks (Morros de

S. Juan, de S. Sebastian). It contains strata of black hornstone, which passes into siliceous schist or Lydian stone (Morro de Barcelona) and Egyptian jasper to the south of Curataquiche. Over this compact limestone is placed, as on Jura, very beautiful alabaster in large masses at Soro, in Golfo Triste. All this gypsum contains sulphur as well as the gypsum of Bex and Kretzetzow, and in the Carpathians. This formation of limestone, with black hornstone and gypsum, seems also to occur in the valley of the Amazon and Rio Negro, where they were found by la Condamine near Cuença, between Racam and Guyausi, on the east side of the Andes.

This limestone and gypsum (the latter in the llano of Barcelona near Cachipé) are often covered in the valleys of Orinoco, and the Amazon river, by a conglomeration or sandstone, with large strata, in which the remains of limestone, quartz, Lydian stone, all of greater antiquity than the sandstone itself, occur. This conglomeration, breccia, which has a similarity to that of Aranjuez, Salzburg, &c., is extended over more than 18000 square miles in the llanos. It contains strata with small grains and traces of brown and red iron ore. I have never seen petrifactions in it.

The sandstone full of shells and coral, without any traces of crocodiles in a country which unfortunately contains so many, and which passes into limestone, but on closer examination is intermixed with grains of quartz, is of newer formation, and always nearer the coasts: P. Araya, Cabo Blanco, Castillo, S. Antonio de Cumana.

It may perhaps be expected that I should close this description with an enumeration of the volcanic productions of this country, which has been convulsed by the most terrible earthquakes, the high summits of which (Duida), and lately some of its caverns (Cueva du Cuchivano), vomit forth flames, where boiling springs are thrown up from Golfo Triste to the Sierra Nevada de Merida (the springs of Triachevar I found to be 72°·3 of Reaumur), where, on the coast of Paria, near Cumacator, there is an air volcano, the noise of which is heard at a great distance, and sulphureous pits in several places as at Guadaloupe—a country where, in the extent of several square miles, the whole surface is undermined and hollow (Tierra Hueca de Cariaco), where, in the year 1766, the earth, after being agitated eleven months by violent shocks, opened on all sides, and poured forth sulphureous water and bitumen; and where, in the midst of the driest plains in the Mera de

Guanipa

Guanipa and du Cary, flames burst from the earth. But nature discharges me from this task. The effects of the volcanoes in this part of the world are very different from those seen in Europe. Great and melancholy in their consequences, they change the rocks which are exposed to their action. The immense revolution of Pelileo and Tonguragua de Zuito has not only covered the earth with lava, but with clayey mud, deposited by the sulphureous water which spouted from the earth. The sulphureous gypsum, the mixture of sulphureous pyrites in all the rocks, even in granite, the bituminous saline clay, the rock oil, or asphaltum, which every where floats on the water or lies on the ground, the immeasurable quantity of rain-water, and the lakes which penetrate into the earth heated by the sun, the aqueous vapours and immense quantities of hydrogen gas every where disengaged, seem to be the principal causes which contribute to produce these volcanic effects.

The sulphureous pits of Guadaloupe, of Montmisene, St. Christopher de l'Oualiban, St. Lucia, and Montserrat, are in all probability connected with those on the coast of Paria. These volcanoes, however, belong rather to the province of natural philosophy than of mineralogy; and I must visit other countries before I can venture to form any opinion on so difficult a subject. May Heaven avert from the eastern side of New Andalusia such a catastrophe as that which has convulsed the plains of Pelileo!

XXXII. *Observations on the Condition of the Inhabitants of the Cape of Good Hope*.*

If the condition of mankind was to be estimated entirely by the means it possessed of supplying an abundance or preventing a scarcity of the necessary articles of life, and it must be confessed they constitute a very essential part of its comforts, the European colonists of the Cape of Good Hope might be pronounced amongst the happiest of men. But as all the pleasures of this world are attended with evils, like roses placed on stems that are surrounded with thorns, so these people, in the midst of plenty unknown in other countries, can scarcely be considered as objects of envy. Debarred from every mental pleasure arising from the perusal of books or the frequent conversation of friends, each suc-

* From Barrow's Travels, vol. ii.

ceeding day is a repetition of the past, whose irksome sameness is varied only by the accidental call of a traveller, the less welcome visits of the Bosjesmans, or the terror of being put to death by their own slaves, or the Hottentots in their employ. The only counterpoise to this wearisome and miserable state of existence, is a superfluity of the necessaries of life, as far as regards the support of the animal functions, which all, of every description among the colonists, have the means of acquiring with little exertion either of body or mind.

A short sketch of the circumstances and resources of the several classes of the colonists will be sufficient to convey a general idea of their respective conditions. The twenty-two thousand Christian inhabitants that compose the population of this colony may be reduced into four classes:

1. People of the town.
2. Vine-growers.
3. Grain-farmers.
4. Graziers.

1. The people of the town we have already observed to be an idle, dissolute race of men, subsisting chiefly by the labour of their slaves. In order to derive a fixed income, and to avoid any trouble, they require each slave to bring them a certain sum at the end of every week; all that he can earn above this sum is for himself, and many are industrious enough to raise as much money in a few years as is sufficient to purchase their freedom, and sometimes that of their children. The price of provisions, and the price of labour, bear no sort of proportion: Butchers' meat is only about twopence a pound, and good brown bread, such as all the slaves eat, one penny a pound. A common labouring slave gets from two shillings to half-a-crown a day, and a mechanic or artificer five and six shillings a day. The people of Cape Town are almost all of them petty dealers, and they have a remarkable propensity for public vendues. Not a day passes without several of these being held both before and after dinner. And it is no uncommon thing to see the same identical articles exposed at two different sales the same day. In fact, a vendue is a kind of lottery. A man buys a set of goods in the morning which he again exposes to sale in the evening, sometimes gaining, and sometimes losing. Yet all moveable property on sale by public auction is liable to a duty of five per cent, $3\frac{1}{2}$ of which the auctioneer is accountable for to government; the remainder is for himself. I cannot give a stronger instance of the rage for vendues than by observing that, in four successive

cessive months of the year 1801, the amount of property sold by public auction was 1,500,000 rix dollars, a sum equal to the whole quantity of paper money in circulation, which, indeed, may be considered as the only money, of late years, that has circulated in the country. In what manner, therefore, these articles were to be paid for is a sort of mystery, which, however, the declining state of the colony may before this have explained.

The better sort of people are those who are employed in the different departments of government, but their salaries were so small that most of them were petty merchants. Others have estates in the country, and derive a revenue from their produce. Others again are a sort of agents for the country boors, and keep houses to lodge them when they make their annual visit to the town. These are a kind of Jew brokers, who live entirely by defrauding the simple boors, in disposing of their produce and purchasing for them necessaries in return. A boor in the Cape can do nothing for himself. Unaccustomed to any society but those of his family and his Hottentots, he is the most aukward and helpless being on earth when he gets into Cape Town, and neither buys nor sells but through his agent. The emancipated slaves and people of colour are generally artificers; many of them support their families by fishing. During the whole year there is great plenty and variety of fish caught in Table Bay, and cheap enough for the very poorest to make a daily use of.

House-rent, fuel, and clothing are all dear; yet, I will be bold to say, there is no town nor city in all Europe, where the mass of the people are better lodged or better clothed; and fire is less necessary here than in most parts of Europe. The keep of a horse in Cape Town was never less, under the English government, than 25l. sterling a year, yet every butcher, baker, petty shopkeeper, and artificer, had his team of four, six, or eight horses, and his chaise. It is true, his horses were lent out for hire one day, and drew himself and his family another; but still it seemed inexplicable how they contrived to keep up an establishment so much beyond their apparent means. Their creditors, I imagine, long before this, will best be able to give a satisfactory explanation, since British money has ceased to circulate among them.

It is true they are neither burthened with taxes nor assessments. Except on public vendues and transfer of immovable property, government has been remarkably tender in imposing on them burthens, which, however, they might

very well afford to bear. Their parochial assessments are equally moderate. At the first establishment of the colony, a kind of capitation tax was levied under the name of *lion and tyger money*. The fund so raised was applied to the encouragement of destroying beasts of prey, of which these two were considered as the most formidable. But as lions and tygers have long been as scarce in the neighbourhood of the cape, as wolves are in England, the name of the assessment has been changed, though the assessment itself remains, and is applied to the repairs of the roads, streets, water-courses, and other public works. The sum to be raised is fixed by the police, and the quota assigned to each is proportioned to the circumstances of the individual; the limits of the assessment being from half-a-crown to forty shillings. The persons liable must be burghers, or such as are above sixteen years of age, and enrolled among the burgher inhabitants. The ordinary amount is fixed at about five thousand rix dollars a year.

Another assessment, to which heads of families are liable, is called *chimney and hearth money*. This is, properly speaking, a house tax, fixed at the rate of eighteen pence a month, or 4¼ rix dollars a year, for every house or fire-place. This should seem to be an unfair assessment, as the richest and the poorest inhabitant, the man with a large house and he who possesses only a cottage, are liable to the same contribution; as it is presumed that every house has its kitchen fire-place and no other. The amount of this assessment is about five thousand two hundred rix dollars, which, at the above rate, corresponds very nearly with the number of houses in the town.

They are subject to no tythes nor church-rates whatsoever towards the maintenance of the clergy; these being paid in the most liberal manner out of the treasury of government. Nor is any demand made upon them for the support of the poor. The very few that, through age or infirmities, are unable to maintain themselves, are supported out of the superfluities of the church. Where the mere articles of eating and drinking are so reasonably procured as in the Cape, it is no great degree of charity for the rich to support their poor relations, and, accordingly, it is the common practice of the country. Those who come under the denomination of poor are, for the most part, emancipated slaves, who may not have the benefit of such relations. Nor does the church provide for such on uncertain grounds. Every person manumitting a slave must pay to the church fifty rix-dollars, or ten pounds, and at the same

time

time give security that such slave shall not become burthensome to the church for a certain number of years.

The police of the town is committed to the management of a board consisting of six burghers, called the burgher senate. The functions of this board are various and important; but they are performed in that careless and slovenly manner which is ever the case where men are compelled to accept an office to which there is annexed neither pay nor emolument. The only exception that I know of is in the situation of an English justice of peace. In every public employment of a permanent nature, like that of the burgher senate, if the emoluments are not such as to make it worth a man's while to keep his place, the odds are great that the duties of it will be neglected. This was the rock upon which the Dutch, in all their East India settlements, split. The appointments of their servants were so small, that those who held them could not live without cheating their employers; and this was carried on to such an extent, as to become a common observation, that in proportion as the Company's finances were impoverished, their servants were enriched.

The business of the burgher senate consists in seeing that the streets be kept clean and in proper repair; that no nuisance be thrown into the public avenues leading to the town; that no encroachments be made on public property; that no disorderly houses be suffered to remain; no impositions practised on the public; no false weights nor measures used. They are authorized to regulate the prices of bread; to enquire from time to time into the state of the harvest; and to take precautions against a scarcity of corn. They are to devise measures and suggest plans to government that may seem proper and effective for keeping up a constant succession of coppice wood for fuel in the Cape district. They are directed to take particular care that the tradesmen of the town, and more especially the smiths and cartwrights, impose not on the country boors in the prices of utensils necessary for carrying on the business of agriculture. They are to report such crimes, trespasses, and misdemeanors, as come within their knowledge, to the Fiscal, who is the chief magistrate of the police, and attorney-general of the colony.

It would be in vain to expect that such various and important duties should be faithfully fulfilled for a number of years without any consideration of profit or hope of reward; or that every advantage would not be taken which the situation might offer. Some of the members of the burgher se-

nate sent their old and infirm slaves to work at the public roads, and received for them the same wages as were paid to able-bodied men; others had teams of horses and waggons that never wanted employ. These things are trifling in themselves, but the public business suffered by it. When the English took the place, the streets were in so ruinous a condition as scarcely to be passable with safety. A small additional assessment was laid upon the inhabitants, and in the course of five years they had nearly completed a thorough repair of the streets, to the great improvement of the town. If they should be induced to light the streets with lamps, it would not only add greatly to the embellishment of the town, but prevent a number of accidents that happen in the night time among the slaves. It would also tend to the encouragement of the whale fishery there. But the greatest of all improvements, and one easily to be accomplished, would be to conduct the water into the houses. The head of the spring, where it flows into the pipes which conduct it to the present fountains, is higher than the roof of the highest house in the town; yet, by a strange piece of ignorance or perverseness, they have carried it down to the lowest point on the plain leading to the castle, so that those who live at the upper end of the town have half a mile to fetch water, which is done by two slaves, who consume many hours in the day in this employ, and are a great annoyance to the public fountain, where they are quarrelling and fighting from morning till night.

The pleasures of the inhabitants are chiefly of the sensual kind, and those of eating, drinking, and smoking predominate; principally the two latter, which, without much intermission, occupy the whole day. They have no relish for public amusements. They have no exercise but that of dancing. A new theatre was erected, but plays were considered to be the most stupid of all entertainments, whether the performance was English, French, or German. To listen three hours to a conversation was of all punishments the most dreadful. I remember, on one occasion only, to have observed the audience highly entertained; this was at an old German soldier smoking his pipe; and the encouragement he met with in this part of his character was so great, and his exertions proportioned to it, that the whole house was presently in a cloud of tobacco smoke.

There is neither a bookseller's shop in the whole town, nor a book society. A club called the *Concordia* has lately aspired to a collection of books, but the pursuits of the principal part of the members are drinking, smoking, and gaming.

gaming. Under the direction of the church is a library, which was left by an individual for the use of the public, but the public seldom trouble it. In this collection are some excellent books, particularly rare and valuable editions of the classics, books of travels and general history, acts of learned societies, dictionaries, and church history. Books are rarely found in Cape Town to constitute any part of the furniture of a house. So little value do they set on education, that neither government nor the church, nor their combined efforts, by persuasion or extortion, could raise a sum sufficient to establish a proper public school in the colony; and few of the natives are in circumstances to enable them to send their children for education to Europe. But those few who have had this advantage generally, on their return, relapse into the common habits of the colonists. I repeat, that if the measure of general prosperity was to be estimated according to the ease of procuring abundance of food, the people of the Cape may be considered as the most prosperous on earth; for there is not a beggar in the whole colony, and no example of any person suffering for want of the common necessaries of life.

2. The wine-growers, or as they are usually called at the Cape the wine-boors, are a class of people who, to the blessings of plenty, add a sort of comfort which is unknown to the rest of the peasantry. They have not only the best houses and the most valuable estates, but, in general, their domestic economy is managed in a more comfortable manner than is usually found among the country farmers. Most of them are descendants of the French families who first introduced the vine. Their estates are mostly freehold, in extent about one hundred and twenty English acres, and the greater part is employed in vineyards and garden-grounds. Their corn they usually purchase for money or in exchange for wine. Their sheep also, for family use, they must purchase, though many of them hold loan farms on the other side of the mountains. The produce of their farms, however, is sufficient for keeping as many milch cows as are necessary for the family, and they have abundance of poultry. The season for bringing their wine to market is from September to the new vintage in March, but generally in the four concluding months of the year; after which their draught oxen are sent away either to their own farms or others in the country till they are again wanted. The deep sandy roads over the Cape isthmus require fourteen or sixteen oxen to draw two leggers of wine, whose weight is not $2\frac{1}{2}$ tons.

The

The tax upon their produce is confined to that part of it which is brought to the Cape market, and is at the rate of three rix dollars for every legger of wine, and the same sum for every legger of brandy that passes the barrier. All that is consumed at home, or sold in the country, is free of duty. Neither are they subject to any parochial taxes or assessments, except a small capitation tax towards the repair of the streets and avenues leading to the town, and the *lion and tyger money* for the exigencies of the district. They are equally exempt, with the people of the town, from church and poor rates; the former being liberally provided for by government, and the other description of people not being known in the country districts. The wine-farmers take their pleasure to Cape Town, or make frequent excursions into the country, in their tent waggons drawn by a team of six or eight horses; an equipage from which the boor derives a vast consequence over his neighbour, who may only possess a waggon drawn by oxen.

The following rough sketch, which was given to me by one of the most respectable wine-boors, of his outgoings and returns, will serve to show the condition of this class of colonists:

Outgoings.

The first cost of his estate was	-	R. D.	15,000
15 slaves *a* 300 Rd. each	-	-	4,500
80 wine leggers *a* 12	-	-	960
Implements for pressing, distilling, &c.		-	500
3 team of oxen	-	-	500
2 waggons	-	-	800
Horse-waggon and team	-	-	900
Furniture, utensils, &c.	-	-	2,000
		Amount	25,160

Interest 6 per cent. R. D.	1509	5
3 Sheep per week for family use, 156 per year, *a* 2½ - R. D.	390	0
Clothing 15 slaves *a* 15 Rd. each per year -	225	0
Corn for bread 36 muids *a* 3 Rd. - -	108	0
Tea, coffee, and sugar - -	150	0
Clothing for the family and contingencies -	350	0
Duty at the barrier on 120 leggers of wine and brandy	360	0
Wear and tear 100 Rd. parochial assessments 20	120	0
Amount of outgoings carried over	3212	5

Amount

Amount of outgoings brought over	R. D.	3212 5

Returns.

100 leggers of wine brought to market *a* 30	3000	
20 ditto of brandy ditto *a* 50 -	1000	
The wine and brandy sold to the country boors, with the fruit and poultry brought to the Cape market, are more than sufficient to balance every other contingent and extraordinary expense.		
Amount of returns	4000	4000
Balance in favour of the farmer	R. D.	787 3
	or £.	157 8 3

which sum may be considered as a net annual profit, after every charge on the farm and on housekeeping has been defrayed.

The payment of an estate purchased is made easy to the purchaser. The customary conditions are to pay by three instalments, one-third ready money, one-third in one year, and the remaining third at the end of the second year; and the latter two-thirds bear no interest. And even the first instalment he can borrow of government, through the loan bank, by giving the estate as a mortgage and two sufficient securities. So that very large estates may be purchased at the Cape with very little money, which is the chief reason of the multiplicity of vendues.

[To be continued.]

XXXIII. *Intelligence and Miscellaneous Articles.*

GEOLOGY.

The block of gypsum found at Pantin two or three months ago, containing a considerable portion of the skeleton of a quadruped, has been purchased by the prefect of La Seine, and given by him, in the name of the commune of Paris, to the Museum of Natural History. The administrators have entrusted the examination of it to M. Cuvier, one of their members.

This quadruped is not a ram, as supposed, and as mentioned

tioned in the last number of the Philosophical Magazine, but one of those unknown species the bones of which are found dispersed throughout the plaster quarries in France, and which constitute an intermediate genus between the rhinoceros and the tapir: only detached parts of this animal have hitherto been found, such as fragments of the head, feet, &c.; and it was by comparing these scattered portions that Cuvier was able to form a complete skeleton.

The block of Pantin has the advantage of containing more parts than ever were before seen together, and consequently of confirming the results obtained, by uniting the fragments previously found.

It contains a lower jaw, an upper and a lower molar tooth, the vertebræ of the neck, those of the back and loins, the ribs, the omoplata, the humerus, the bones of the fore-arm, a portion of the pelvis, one of the femur and one of the bones of the leg; but the head and feet are wanting.

As the head and feet, however, had been before found in other blocks, the parts lately obtained complete the knowledge of the species; and are the more valuable as it will be difficult to find them united in an order so near to that of life.

This quadruped is one of the eleven species already determined by M. Cuvier, from bones found in the plaster pits of France, and of which no living specimen has yet been found on the surface of the globe by any traveller or naturalist. Its height is superior to that of the fox, and less than that of the sheep. The block of Pantin shows that it had at least sixteen ribs. All the species of the genus to which it belongs, and which Cuvier distinguishes by the name of *palæotherium*, had, like the one in question, molar teeth very like that of the rhinoceros, with canine teeth and incisors like those of the tapir, and the form of the bones of the head render it probable that, like the latter, they had a trunk*.

As the remains of these animals now lost are of great importance to the history of the globe, the administrators of the French Museum of Natural History wish very much to obtain a complete collection of those found in the neighbourhood of Paris. They have therefore requested all the proprietors of plaster pits, or persons residing in the neighbourhood of them, to collect and transmit to them such

* See a history of these animals in the Annales du Museum d'Histoire Naturelle.

blocks

blocks as contain bones in a state of good preservation, with a promise of returning them, if desired, after they have been examined. The names of the persons who choose to present articles of this kind will be inscribed on them when publicly exhibited, and rewards have been offered to those labourers who succeed in preserving bones entire.

A work by Mr. Parkinson, of Hoxton, on the organic remains of the former world, is in considerable forwardness. The first part, on the fossils of the vegetable kingdom, illustrated with coloured plates, in quarto, will, we understand, be published on the 1st of June next.

HUMBOLDT'S TRAVELS.

M. Humboldt, the Prussian minister at Rome, received, in the beginning of February, letters from his brother, dated Valladolid, in Mechoacan, September 24, 1803. This celebrated traveller had descended into the crater of the volcano of Torcello, which still burns, to the depth of seventy toises, being only about fifteen toises from the bottom. He states that the examination of this volcano, which has existed only since the 29th of September 1759, will enable him to throw considerable light on the nature of these terrible phænomena. His letters do not give so positive hope of his speedy return as that of the 11th of August. He says he waits, before he embarks, for a good vessel, and the total cessation of that malady known by the name of the *vomito negro*, which at that time occasioned great ravage at La Vera-Cruz. These two circumstances, he adds, may retard his departure till the spring. He and his fellow-travellers were in perfect health.

CURING OF MEAT.

The following curious receipt for curing fresh provisions to carry abroad, has been tried by a gentleman who has twice made the experiment on a voyage to Archangel, and once to the West Indies:—Let the meat, whether beef or mutton, be fresh killed, and when hung to be perfectly cold, let it be cut up in quarters: lay each on a block, and sprinkle it over with ingredients prepared in the following manner: Lignum vitæ fine chips one pound, common salt four ounces, coarse sugar four ounces, salt prunella half an ounce: when it has been well sprinkled in, close the whole in sheet lead; which done, lay it in a chest, and, as each lot is laid in, cover it with fresh sawdust; ram it well down and cover the whole close. Meat, particularly fine fat beef,

 has

has been eaten fresh, so prepared, six weeks or two months, after sailing from England; the beef must be in fine order, and when taken out for dressing (it roasts best) it should be wiped and scraped clean, and put down to the fire as quick as possible.

MEDICINE.

Dr. Keutsch, an able physician, who practises in the Danish West Indian islands St. Croix and St. Thomas, has established a new method, which has hitherto proved successful, in the treatment of the fevers peculiar to these islands, and which are fatal to the Europeans. He employs friction with oil. The first idea of this process was suggested to him by the theory of Scheele, of Copenhagen, in regard to the use of oil in the plague; a theory which has been published in Baldwin's Recollections respecting Egypt. Of eight soldiers under the care of Dr. Keutsch, six were cured of the fever in the course of twenty-four hours by means of such friction. It produced strong perspiration, and checked the vomiting. The doctor in some cases rendered the effect of the friction more efficacious by adding camphor to the oil. This discovery is no doubt valuable: the fever cured by this process is the same as that which occasioned so much ravage at St. Domingo.

CHEMISTRY.

It appears by the following letter from C. F. Bucholz to the editors of the *Neues Allgemeines Journal der Chimie*, dated Erfurt, October 11, 1803, that there is no such simple earth as that called *agust earth*:—"The agust earth discovered some years ago by professor Tromsdorff*, and afterwards confirmed by the experiments of Richter to be a peculiar kind of earth, no longer exists. About a fortnight ago I procured some of this earth for the purpose of subjecting it to examination, and had proceeded so far that it was ready for being washed and dried; when, in consequence of a large quantity of lime which in presence of my friend Haberle I precipitated by pure carbonate of potash from the muriatic fluid from which this earth, several times treated with ammonia, had been precipitated, I began to doubt of the simplicity of the agust earth. My friend Tromsdorff, to whom I communicated my experiments, now informs me that he has found that the agust earth is not simple; he considers it as a combination of lime and an acid, probably the phosphoric. As he had too small a quantity of

* Philosophical Magazine, vol. vi. p. 287.

agust

agust earth to confirm this suspicion by experiments, he requested me to pay attention during my researches to the acid. I made experiments for the purpose, and was so fortunate as to produce phosphorus and phosphoric acid, and to find that the so called agust earth is actually phosphate of lime. M. Haberle and myself made some experiments on the phosphorescence of pulverized crystals of agustite, which when thrown on a hot plate of iron give a very lively bright green light: a crystal of agustite rubbed on a piece of woollen cloth exhibited a very strong attraction for small bodies. All these circumstances assign to the fossil hitherto called agustite a place near to apatite. The phosphate of lime, therefore, has been three times given out as a simple earth; as ivory earth, bone earth, and agust earth. It is therefore probable that chemists in future will not be so easily led into this kind of error.

IMPROVEMENT IN GEOGRAPHY.

Mr. Churchman, author of the magnetical charts, has proposed an improvement in the construction of maps, by which the altitude, declivity, and perpendicular height of the hills and mountains throughout any country or any particular district can be indicated. This plan consists in tracing certain lines over the surfaces of the parts intended to be so marked, and is applicable to maps already published; that is, to such as have been constructed by a proper survey, as the map of Kent, which has been performed at the public expense, and published under the direction of the Board of Ordnance, and other maps now executing in a similar manner. The lines are rendered efficient for the purpose proposed, by employing with them an universal proportion to ascertain their respective indications. Such maps would probably be useful for military purposes as well as for matters respecting canal navigation.

METEOROLOGICAL TABLE*

For March 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Weather.
1804. Feb. 25	30°	36°	30°	29·84	Fair
26	28	39	39	30·01	Fair
27	40	47	38	29·92	Cloudy
28	36	36	29	·85	Rain and hail showers
29	29	36	29	·90	Fair
March 1	28	34	28	·86	Fair
2	27	34	29	·84	Fair
3	30	38	34	·60	Cloudy
4	34	34	36	·40	Snow
5	37	46	38	·35	Cloudy
6	39	47	39	·32	Showery
7	38	49	38	·66	Fair
8	37	51	45	·73	Fair
9	45	52	46	·51	Rain
10	43	53	46	·69	Foggy
11	47	55	45	·72	Fair
12	42	57	46	·72	Fair
13	46	58	49	·82	Fair
14	46	59	48	·86	Fair
15	48	59	49	·79	Fair
16	44	55	48	·75	Foggy
17	43	56	44	·72	Fair
18	42	39	35	·59	Rain
19	34	35	32	·51	Snow
20	32	33	32	·62	Cloudy
21	32	35	31	·86	Fair
22	31	38	30	·70	Fair
23	30	41	38	·60	Cloudy
24	32	47	37	·79	Fair
25	42	47	43	·50	Cloudy
26	43	48	38	·25	Showery

* By Mr. Carey, of the Strand.

ERRATUM.

Page 123, l. 35, for "Table of *Parallaxes*" read "Table of *Refractions*."

XXXIV. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* David Mushet, *Esq. of the Calder Iron-Works*.*

The subject of the present inquiry, which has long engaged my attention, is of considerable importance in the œconomy of the manufacture of iron, and is a necessary key to the development of many facts connected with that truly philosophical process. To the chemist and the philosopher it will most probably be more acceptable than to the manufacturer. A long continued train of success and experience frequently exalts the latter in his own opinion beyond the confines of elementary science. Conscious of his attainments by practice both in the quality and quantity of his results, he seldom acknowledges the existence of chemical and philosophical principles; or, if he does, it is merely to shade them with that ridicule which is often the bane of useful inquiry.

If we were certain that we had reached the ultimate progress of discovery in the properties and affinities of the most useful metal hitherto discovered, then the injury done to science and the arts, by avoiding all inquiries to explain upon simple principles the agency employed in the manufacturing of iron, would be of less importance. But if the matter is impartially investigated, there will be found sufficient reason to apprehend that our knowledge and general progress in the iron trade are more applicable to quantity than quality. The successful exertions of individuals have increased the manufacture of cast and malleable iron beyond all precedent in this country; nor have we been without some enlightened individuals who have laudably endeavoured to form a superior quality along with the extension of their manufactures. Success has so far crowned their praise-worthy exertions, aided by the operation of knowledge in removing the prejudices of the artisan, that bar iron of our own manufacturing has been substituted to a great extent, in place of that formerly used of the Swedish and Russian marks. But hitherto all attempts have failed to make bars of a proper quality to form steel in any degree comparable

* Communicated by the Author.

comparable to that we daily manufacture in great quantities from foreign iron.

Here we remain at an immense distance behind; and while our manufacture of iron goods exceeds the collective exertions of all Europe, we humbly feel our dependence upon two foreign markets for the supply of that steel iron, without which the beauty, the utility, and extent of our hardware manufactures would be essentially injured and abridged.

The policy of the foreign holders of this article communicates many undue advantages to the favourite few to whom the steel iron is consigned in this country. The rapid progressive rise in value of this iron for ten years past, has already nearly doubled the price of steel to the workman, and given the trade in general a melancholy foretaste of the evils of dependence and monopoly *. This is not all; the importers of steel iron avail themselves of their advantageous connection, and generally annex, as a condition of purchasing, that the steel manufacturer shall buy a proportion of inferior or common marks. This he is frequently obliged to do, and take his chance of the market in disposing either of all or of part of this obligatory purchase. The consequences are obvious; only large capitalists can in general enter the trade, and these most naturally will cover their probable risk of loss upon the sale of a superfluous stock of bar iron by an additional tonnage upon the price of blistered and manufactured steel.

There are few but are convinced that there exists some material difference betwixt us, the Swedes, and Russians, in the form or minutiæ of our processes for making bar iron respectively, in the nature of our fuel, or in the construction of our ores. If the most faithful imitation of the foreign processes for the making of bar iron has completely failed in forming quality, then the difference must lay betwixt the nature of pit coal fuel and that of wood; or the fossil construction and combination of an endless variety of secondary ores, contrasted with the richer, the magnetic, and more metallic ores of the Swedish and Siberian mines.

If the analysis of pit coal furnish us with data sufficient

* It was reported some years ago, that the mine of Danamora in Sweden, from the ore of which 4 to 5000 tons of steel iron of the best marks are yearly made, had been inundated by the overflowing or bursting of a neighbouring lake. The holders of iron in this country immediately speculated upon an unheard-of rise in the price of this article, which was fortunately soon after counteracted by a certainty of the mischief not being nearly so extensive as was first apprehended.

to assert, that after proper distillation, or coaking, the residuum coke is equally purely compounded, at least in many instances, as the charcoal obtained from the combustion of wood, then the chief weight will hinge upon the different qualities of the ores introduced into the smelting furnace here and abroad *.

If this supposition is well founded, the constituent parts of our ores, and the effects of their mixtures respectively, surely become an object of the highest consideration.

There are now nearly 150 blast-furnaces at work in Britain. the produce of many of which, as to quantity, may be alike, but each of which will most likely possess some distinguishing characteristic mark as to quality. It is also very generally understood, that the native impression or peculiarity of quality adheres to the metal in every subsequent stage of operation. Weak or fusible pig iron requires not only a greater quantity to waste to form a ton of bars, but is afterwards found possessing an inferior degree of malleability and tenacity. On the contrary, strong or refractory pig iron forms malleable iron with greater facility, of course with a less loss of metallic matter, and constitutes what is well understood by the term *a strong body of iron.*

The means employed to render each of them malleable being alike in both cases, though an investigation of this subject might not be immediately productive of any advantage to the mere manufacturer of pig iron; yet, as it might tend to unfold the causes of several admitted effects in the operations of the blast-furnace, and tend to develop some affinities not hitherto suspected of being brought into play, it would ultimately throw light upon the fabrication of bar iron and steel: a desideratum of much importance to the community.

Arrangement and classification seem in all systems and theories the grand primary steps towards knowledge and perfection. Impressed with this truth, I ventured several

* I mean that this assertion should be confined to some pit coals only, and to the quantities of carbon and ashes which enter into their composition. In many instances I have found the coke of pit coal more free from ashes, and containing of course a larger proportion of carbon than the general run of woods. What difference may result in the manufacturing of iron with such coals, arising from the residuum or ash being chiefly an earthy mixture, and wood, the residuum of which is chiefly alkaline, I never have determined by direct experiment. This important and extensive field of investigation still lies open and unexplored to the manufacturer and the chemist, or both. I have alluded to it in one of the subsequent paragraphs of this paper, as forming a part of an important and national branch of inquiry.

years

years ago, through the medium of this publication, to arrange our iron-stones, generally denominated "secondary argillaceous ores of iron," into four classes, viz. calcareous, argillaceous, siliceous, and class of equal mixtures. I have since added to these, three new classes, not hitherto, I believe, acknowledged as iron-stones, viz. carbonaceous, bituminous, and granulated: the two former classes, if ever examined or suspected as belonging to the varieties of secondary ores, were either considered as coal or rejected as whin stone. Analysis, however, by the separation of a large portion of metal from each, taught me to value them accordingly, and to rank them as real secondary ores of iron possessed of new and interesting features.

Of the first four classes, the varieties chiefly used at iron-works are those of the class I have styled "equal mixtures." But as the combination of lime, clay, silex, iron, and oxygen, is susceptible of an almost endless variety of modification before any one earth exclusively predominate, even the same class of ores may in their results afford a similar variety in the peculiar or native properties of the metal which it contains. Under this class we find numerous modifications of calcareous earth crystallized, in the state of spar, on marine remains, disseminated, or in chalky lines parallel or intersecting each other throughout the fracture of the ore.

The next supply in point of quantity is derived from the argillaceous ore; but there are but few varieties of this class that approach to any great degree of purity.

Calcareous iron-stone in its purest state is extremely scarce, and is as yet no where found in quantity excepting upon the Whitby and Scarborough coast. Its appearance being very different in point of colour from common iron-stones renders it an object of suspicion to the iron-master in general; and there are but few varieties hitherto that have been permitted to enter the precincts of the furnace-yard. The union of lime, however, in the common qualities of iron-stone forms a striking and interesting character, which is frequently beneficially felt by admitting a reduction of that quantity of lime-stone in the furnace which ore highly argillaceous would require.

The siliceous class of iron-stones seldom or ever form any part of the supply of the manufacturer, and I believe their existence in a state comparatively pure is equally unknown to him and the mineralogist. In general it may be remarked, that at all iron-works iron-stones containing a larger proportion of sand than common are carefully rejected,

jected, for containing "bad iron." This prejudice, without stopping to inquire into the correctness of the deduction, has tended to lock up from general examination numerous strata of iron-stones which unfortunately were impressed with the usual external characteristics of the siliceous genus of stones. Many of these equally rich in iron, with some of those used in the blast-furnace, are buried in the rubbish of quarries, or contumeliously branded as a mischievous variety of sand-stone.

The general theory founded on practice, and which is commonly admitted at iron-works, is, that that iron-stone is best which fluxes itself, or that, in other words, contains a considerable proportion of lime in the state of crystal, spar, or otherwise. The assertion is, and I believe it to be just, that such iron-stones tend more to make "sulphury iron," *i. e.* iron richly carbonated, than any other variety: hence these are always in great request. Again, those varieties of iron-stones that present smooth fractures of a dull blackish or grayish black, or gray or grayish white colour, and uniform throughout, are held next in estimation at iron-works. These, with the same justness of remark, make "good iron;" but their tendency to form "sulphury iron" is inferior. The fracture of pig iron made from such iron-stones is generally less brilliant than from the former, seldom presents a carburated surface, but by many is preferred for excellent melting iron. These varieties generally arrange themselves under the argillaceous class of ores. In these the manufacturer adds another, which is merely a modification of the same class, but united to an evidently large proportion of sand. The theory which is here applied is, that such iron-stones make a coarser quality of iron than the former, and that, when the quantity on the furnace is increased beyond a certain proportion, the quality of the metal becomes hard or less carbonated.

These facts, which seem to result from general practice, may be thus shortly arranged, every circumstance being alike to all:

1st, Calcareous iron-stone has a direct tendency to manifest a larger proportion of carburet than any other class in the blast-furnace, and of course enhances at the same time the absolute value of the metal.

2d, Argillaceous iron-stones form iron of an equal quality in the estimation of some, but in manufacturing exhibit always a less apparent existence of carbon and an inferior tendency to carburate.

3d, Siliceous iron-stones have uniformly a tendency to

 destroy

destroy or secrete the existing carbon in the furnace; reduce its absolute quantity in the pig, and lower its value to the manufacturer. From this arrangement it will be easy to explain the full meaning of the manufacturer when he designates the product of any ore "bad iron." The phrase is merely relative, and only implies a want of saturation of the coaly principle, and does not extend to the after results of the metal, supposing it underwent the manipulations of the forge. The contrary is the fact; for the "bad iron" of the pig iron maker is the most suitable to the purposes of the forge, whether its intrinsic value in the market is considered, or its facility in forming bar iron with much less loss than when carbonated metal is operated upon.

With this fact before us, are we justifiable in condemning to perpetual oblivion, without trial and without examination, every ore of iron that is not as profitable as another in the blast-furnace for the manufacturing of gray or melting pig iron? May not the converse of the above propositions hold good? and may it not ultimately be discovered, that argillaceous and siliceous iron-stones, which yield inferior qualities of melting pig iron, form a quality best calculated for the purposes of the bar iron forge?

The universal run in favour of easily carbonated iron, and the general result of the quality of bar iron at most of the forges in the kingdom, give a shade of probability to this supposition.

To prosecute an inquiry into the fact itself would open an extensive field of rich investigation. The subject divides itself into three principal branches. The first, to which this paper is meant as introductory, is an inquiry into the affinities exerted by the different earths, which commonly enter into the composition of iron-stones, upon the carbon of the furnace, and to ascertain how far and to what extent these retard or promote the carbonation of the metal.

The second and most laborious branch would be, by direct experiment to form portions of cast iron, malleable iron, and steel, from one particular oxide of iron, (or from any iron ore whose properties were nicely ascertained, to serve as a general standard,) mixed and fused with different earths, and in various proportions. Thus a rigorous scale of comparison would be easily formed from the results thus obtained, as to every possible shade of quality which most probably results from certain affinities existing betwixt the metal and earths Chemical analyses would finally close this division of useful labour, by enabling us to compare with foreign

foreign irons the residua afforded by our various qualities in the different stages of manufacture.

The third and not the least interesting province of national inquiry, and which would form an essential epoch in the history of iron making, would be a practical analysis of the numerous qualities of pit coal; not merely to ascertain the quantities of bitumen, carbon, and ashes which they contain, but by forming real metallic products by means of each quality, and subjecting these to positive and comparative trials, enable us to pronounce which are best calculated to promote the general interest of the manufacture.

In the pursuit of knowledge in this laborious, sable, but very interesting field, science might ere long, and without any visionary effects of a fanciful imagination, establish her empire over the regions of the foundry, and by her enlightened steps exhibit to us, even in the most remote and inglorious manipulation of this art, the unerring operation of principle and the general harmony of established causes. Then, perhaps, our labours might be productive of a classification descriptive of the natural product of our ores and fuel. The Germans have long had their steel ore and the Swedes their steel iron; and may not analysis point out, according to the various combinations of our ores, however inferior in many respects, what particular mixture would form the best bar iron, and which the best steel? Already the manufacture of melting cast iron, so far as it relates to a judicious choice of ores, seems thoroughly understood.

The first of these divisions now pointed out being the task I have assigned to myself, I shall proceed to state the train of reasoning which was the foundation of the extensive series of experiments meant to be detailed.

Every day, convinced of the correctness of the practical deductions formerly stated, relative to ores combined with different earths, I was anxious to form an explanation of the causes which would in every particular prove satisfactory of the facts. At one time I attributed the effects of the calcareous iron-stone to the decomposition of carbonic acid in burning the iron-stone, and part of the carbon either uniting to the particles of metal, or, which in effect would nearly be the same thing, carrying off a portion of its oxygen. I again supposed that this effect might be produced by a stronger affinity existing betwixt the iron-stone and the raw limestone added as a flux, the carbonic acid of which might be decomposed, and the carbon attracted by the iron. Having satisfied myself, by direct experiment, that carbonic acid (even admitting it as decomposed) never

affords any carbon to iron in fusion, I was forced to seek a new theory.

I had often remarked that, in forming crucibles, a mixture of plumbago, charcoal, or coke-dust, while it conferred a degree of toughness to the clay in the act of heating, and presented what is by workmen called *clinking*, uniformly created a degree of fusibility beyond the natural tendency of the clay when unmixed. It occurred to me that this fusibility might proceed from a chemical affinity being excited by the clay upon the carbonaceous matter of the addition in very high temperatures, and that something similar taking place betwixt the earths and the carbon in the blast-furnace, might tend to explain, in a satisfactory manner, the phænomena of the different iron-stones.

I immediately considered lime, clay, and silex, in some respects in the same state as the metallic oxides, and particularly similar to the one with which they were united in their earthy state; each of them separating from the common mass, according to their affinities, portions of the carbonaceous matter of the fuel, and either with it becoming a binary compound, or by discharging it in the state of an elastic vapour.

From this theory it seemed consonant with the practical remarks formerly made to deduce, that the fact of calcareous matter in the blast-furnace, and particularly in union with iron-stones, forming iron more carbonated than argillaceous or siliceous ores, might arise from a less degree of affinity subsisting betwixt calcareous earth and carbon, than between the others and that substance: or that, in other words, lime not absorbing at all, or in very small quantities, the carbon of the fuel, a larger portion was left to be united with the iron; and hence followed an easy explanation of its tendency to form carburated or "sulphury iron."

As the products of carbonation diminish by the increase of clay, I immediately inferred that clay absorbed a larger portion of carbon than lime, and this robbed the iron of a portion of its coaly principle. The same reasoning I applied to siliceous iron-stones, but in an extent proportioned to the excessive decarbonation of the metal when these iron-stones are used in quantity.

As all theory, however, seemed objectionable that was not founded upon direct experiment, particularly when the elementary principles could be subjected with ease to their supposed respective affinities, I determined to engage in an undertaking, which, though it at first sight appeared laborious, promised a rich and an abundant harvest.

The

The experiments arrange themselves under the following heads:

1st, On the affinities which exist betwixt lime, clay, and silex, and carbon, in temperatures from 150° to 170° of Wedgewood.

2d, On the affinities which exist betwixt carbon and ores variously compounded, judging comparatively from their metallic results in fusion.

3d, On the affinities which exist betwixt carbon and primary and secondary ores of iron, arranged according to their former classification, judging also comparatively from their metallic results.

[To be continued.]

XXXV. *Researches in regard to the Manner in which Natural Bodies exhibit Colours, and Experiments on a new Theory of that Phænomenon.* *By* S. F. Hermbstadt*.

First Part—*which contains an Examination of the Question, Whether Light be a simple Substance?*

The colour of any object considered as a phænomenon is the result of the sensation impressed on the organ of sight by the effect of the object, and can no further be explained. If the result of this effect is to be defined from physical causes, it is then necessary to follow its producing causes to discover them if possible, and to deduce from them a rational explanation consistent with natural principles.

If we set out from any other principle, the effective causes are considered as accessory things; and no other result can be obtained from our researches than hypothesis susceptible of any modification, and for that reason insufficient.

It was from this principle that the antient philosophers proceeded when they wished to give a proper idea of the production of colours; and therefore it was natural that the hypothesis they formed should be subject to any modification, and readily give place to other hypotheses.

Newton himself, who without doubt is the greatest among the modern philosophers, did not render his hypothesis in regard to light and colours perfectly free from this objection. The experiments which he first made in the year 1666 on the refraction of light, gave him reason to observe its

* From Neues *Allgemeines Journal der Chemie*, by Hermbstadt, Klaproth, &c. vol. ii. no. 1. Berlin 1803.

its close connection with the colours of bodies, and to form from it a system which, as a monument of human ingenuity, is worthy of admiration.

Some of the supports of this system of colours, which at present is made the ground of the explanation given of the phænomena of colours, have been shaken by Euler's hypothesis; but it can by no means be entirely overturned.

Newton's experiments on the refraction of the rays of light, have undoubtedly proved that light must be considered as the first and only cause of all colours, and be made the principle on which they are explained.

But when we found on it the hypothesis, that white light is a mixture of the seven simple coloured rays, which can no longer be decomposed, and when this hypothesis is made the foundation of another, to show how the natural bodies exhibit their colours according as they reflect this or that ray of light and absorb the rest,—this to me appears to be merely an auxiliary hypothesis, capable of explaining the consequence in part, but by no means entirely.

Had Newton, the celebrated author of this system, been as good a chemist as he was a geometrician and philosopher; and had the knowledge of chemistry been as widely extended in his time as it is at present; that great man, as modest as he was free from prejudice, would in the prosecution of his discoveries have proceeded to the first causes; and these researches would have exhibited to so philosophical and accurate an experimenter the object of his inquiries in a different point of view.

This, however, was not the case. Newton, and most of his followers who employed themselves with researches on this subject, examined rather the refrangibility and reflexibility of light than its intimate nature; and therefore it was unavoidable that phænomena should either escape or be concealed from them, which are every moment produced by the action of light, and which in its effects act a distinguished part as the means of producing colours.

Some new experiments which I made on light, and a repetition of those of others, have exhibited to me phænomena which seem to merit attention, as they may serve to enable us to form some opinion in regard to the object in question.

That I may pursue these experiments in systematic order, I shall here mention the ideas which gave birth to them: they were as follows:

1st, Is the white colourless light a simple and not a compound substance?

2d, Is

2d, Is it the product of a mixture of two heterogeneous substances? and in this case, what are the compounding parts?

3d, Does light consist or not in a mixture of seven differently coloured rays? and, if the latter be the case, how and under what circumstances does light act as a medium for the production of colours?

4th, What influence have the matters which in contact with light produce colours on the change of its mixture?

In regard to answering the first question, it will be necessary to determine in general, if possible, whether any thing can exist actually perceptible to the senses in the simple state.

As far as our experience in the knowledge of nature permits us to judge, we must admit among material objects in general, and among the more subtle matters in particular, an incessant and mutual action, which is so powerful, that, in the moment when we endeavour to disengage simple substances from their mixtures, they again enter into new combinations, and exercise on each other a productive power which never ceases.

It hence follows, that the impression by which these matters affect our senses must be considered either as the result of new mixtures; or it must be admitted that these matters, by their mixing and productive power, are capable of exciting ideas of their specific and individual existence.

If this mode of considering the subject be applied to light, it follows, that it must be considered as the result of the mixture of two different component parts. But here a question naturally arises, What are the principles which produce light, considered as the product of their mixture?

As the answer to this question cannot be founded on any question *à priori*, it must be explained by experiment; for it is the result of a research respecting light that can pave the way to a solution of it. With this view the following experiments were made:

Experiment I.

On a bright summer day, when the horizon was obscured by no cloud, a bundle of rays was introduced into a darkened room in such a manner as to cover the bulbs of two thermometers suspended in a perpendicular direction: one of these thermometers, which I shall call A, was at the distance of 12 inches, and the other, B, at the distance of 24, reckoning from the point where the light flowed in.

Observation.—In the course of ten minutes the mercury

in the thermometer A stood at 15° of Reaumur, and that in B at 14°. The former, therefore, was the temperature of the light itself.

Experiment II.

I let the above apparatus remain without any change, but suspended near the thermometer B another, C, the bulb of which was covered with a mixture of chalk and clear gum water, and completely dried.

Observation.—At the end of ten minutes the temperature of the thermometers A and B was the same: in C the mercury stood only at 12 degrees.

Experiment III.

I again left the apparatus in the same state, but in place of the thermometer C substituted a new one, D, the bulb of which was covered with a mixture of gum water and vermilion completely dried.

Observation.—At the end of ten minutes the mercury in A and B was in the same state as before; but in the thermometer D, the bulb of which had been covered with vermilion, it stood at 17 degrees.

Experiment IV.

In the like manner I suspended near the thermometer B another, E, the bulb of which was painted black, with a mixture of lamp-black and gum water.

Observation.—At the end of ten minutes the temperature of the thermometers A and B was as before; but the one E, painted with lamp-black, exhibited the temperature of 20°.

The results of these experiments were striking, but I was uncertain on what principle I could explain them. Two explanations only were possible. 1st, Either the colours which I employed act as conductors of heat: or, 2d, They have different degrees of power to extricate heat from light. To ascertain these points I made the following experiments:

Experiment V.

I took three cylindric glasses of equal thickness, and filled one with dry pounded chalk, another with dry pounded cinnabar, and the third with burnt lamp-black. In each of these glasses I placed the bulb of a thermometer, in such a manner that it was every where covered by the pulverized substance. The three glasses were then deposited in a small wooden box, and hot sand being poured over them, they were left at rest for ten minutes.

Observation.—The temperature of the sand was now 50 degrees

degrees of Reaumur, the thermometer in the chalk indicated the temperature of 35 degrees, that in the cinnabar 40, and that in the lamp-black 35.

It hence follows, therefore, that the conducting power of these substances for heat is as little proportioned as their capacities for it to that heat which the light excites in them: otherwise the lamp-black must have acquired the greatest temperature; whereas it exhibited the lowest, and consequently showed the least power for conducting heat *.

These results, therefore, are a sufficient proof that the light, when it acts on substances of different colours, is capable of producing different degrees of heat, if in their former state they were free from heat.

But it is worthy of remark, that the thermometer painted with chalk exhibited a lower temperature than that of the light which fell upon it; and this shows that white light possesses rather the property of extracting heat from colourless bodies than producing in them heat: which agrees with some other experiments.

If the results of these experiments, therefore, be employed to determine whether light be a simple substance, or a product of the mixture of two different component parts, we are naturally led to adopt the latter idea, namely, that light is not a simple but a compound substance.

We are thus conducted to the answering of the second question, What are the component parts of light? We are taught by the above experiments, that chalk, when it comes into contact with a colourless ray of light, not only produces no heat, but even lessens the absolute heat of the light; and on the other hand, that lamp-black in contact with light is capable of producing the greatest degree of heat.

The latter is the case also when other black objects are subjected to the action of the light, and is confirmed in a striking manner by the well-known experiment, that snow under a piece of black cloth melts much sooner than under white.

It hence follows also, and this is agreeable to Newton's

* The author's inference is in some respects incorrect. The experiment was instituted to determine whether the *colours* he employed acted as conductors of heat, or had different degrees of power to extricate heat from light. The result only proves a certain truth respecting the conducting power of the *substances* employed. The power of all bodies to transmit heat is, in some degree at least, as their densities. Their colours also may affect the result; but from dissimilar substances we apprehend no accurate inference can be drawn respecting the point in question. —EDIT.

principles,

principles, that black objects must be considered as those which absorb the light, and capable of depriving it of its luminous property: on the other hand, those must be considered as white or colourless objects which reflect the light that falls upon them, and for this reason appear white.

But here arises another question—If dark objects destroy the action of the light which falls upon them, while white objects do not, what is the efficient cause of this difference? This question may be easily answered on the principles of Newton by this observation, that black objects absorb the light, and white reflect it.

This explanation, however, is merely an auxiliary hypothesis to attempt to explain something, but it by no means explains the result. Should it be explained on satisfactory grounds, a second question will arise, namely, Why is light absorbed by black objects, and not by white? Is this effect accompanied by particular phænomena, or not? And if this be the case, What are the phænomena which are exhibited for our observation?

If the above experiments be made the ground for an explanation of this point, it thence follows, that in the moment when light is deranged in its luminous action by a black object, an exaltation of its temperature takes place.

But the exaltation of the temperature of a body supposes the existence of free heat. If bodies, however, in a state of rest, exposed to the action of light, can on no good grounds be considered as capable of themselves to extricate heat; and if heat is produced by their contact with the rays of light which are not hot of themselves, light must be considered as that object which contains the principles sufficient for the disengagement of heat.

But if the heat combined with light cannot exercise an action till the light is brought into contact with another object, it must be combined with it in a different form. This union or mixture of two heterogeneous bodies in a new product supposes an affinity between them; and this is a sufficient proof that light must be considered as the product of the mixture of caloric and another substance, which unite by the power of affinity.

We hence see by what means light, in consequence of its action on some bodies, can produce heat, and why this is not the case with others. If an object, therefore, is capable of exciting heat by its contact with light, its attractive power for the matter that produces light must be greater than the attractive power of this matter for caloric. Hence it follows, that the productive matter of light is miscible with other

other matters, and consequently subject to the general laws of chemical or mixing affinity, which places its materiality beyond all doubt. It follows likewise that colourless bodies for this reason when they come into contact with light can produce no heat, because their attraction for the producing matter of light is less than the attraction of this matter for caloric.

Since we are thus naturally induced to consider light as a product or mixture of the producing matter of light and caloric, it will be necessary also to introduce this matter under a characteristic name into the nomenclature of natural elements. But the producing matter of light is not of itself luminous; it assumes this quality in the product of its mixture with caloric, and consequently it must be distinguished by the name of *photogen* from the Greek words φωτος and γεινομαι, which signify to produce light.

Light, and the matter that produces light, must also be as different from each other as cause and effect. The producing matter of light may be a component part of many objects in the world, and be distinguished by different qualities. It may also exist in the concrete form, mixed with other bodies; but it can never exist pure without mixture with other elements, because, as already observed, all elements in nature are in a continual state of mutual reaction, and exercise on each other an incessant power of attraction.

If the producing matter of light and caloric enter into mixture, the result is light; consequently caloric is that element which converts the producing matter of light into moveable or radiant light.

[To be continued.]

XXXVI. *Fourteenth Communication from Dr.* THORNTON *relative to Pneumatic Medicine.*

March 20, 1804.
No. 1, Hinde-street,
Manchester-square.

To Mr. Tilloch.

SIR,

I FEEL happy when I can relate to the philosophic world cures long ago accomplished, which show also the permanency of the benefits received; and the present early case is, I think, a very striking example of the efficacy of the aërial remedy.

Case of Spasms.

Mrs. Gillespie, æt. 35, a married lady, for near a twelvemonth

month was affected with a stomach complaint, as indigestion, flatulence, heartburn, a loathing of animal food, disturbed sleep, great emaciation, a dry cough, and frequent excruciating spasms, with frequent hysteric affections in the throat: her debility was great, and her breathing extremely short upon using the least exertion. Having taken a great deal of medicine to no manner of permanent good, she resolved to try the vital air; and this was as far back as the year 1793, and with the approbation of her apothecary Mr. Bateson, of Gun Dock, a very old practitioner, whose name accordingly deserves to be remembered here. The same plan of medicine was pursued as before: a gallon of vital air, mixed with three gallons of atmospheric, inhaled, and in six weeks this lady was restored to the blessing of health. Being called, a few days ago, into consultation by Dr. Hamilton, respecting this lady's niece, No. 3, Brixton, I was pleased to find Mrs. Gillespie looking extremely well, and she felt more anxious than I might be to have her case generally known to the world.

Observations on this Case by Dr. Thornton.

I. The connection of the oxygenated blood on the stomach is found from the greater degree of appetite experienced by those in the country than when in a confined place, and from the effect of inhaling the superoxygenated air as increasing the appetite in this and other patients.

II. That the spasms should cease is not to be wondered at, as undigested food in the stomach not only makes unconcocted or ill-formed blood, but acts as a local stimulus, ferments, and occasions the extrication of fixed and inflammable airs, and, distending lively parts excessively, throws them into inordinate action;—but once get the stomach right, the main spring of the animated machine, and all then goes on well.

III. This lady at first was so weak, that with difficulty she could get out of the coach up stairs, and the artificial mode of drawing into the lungs the superoxygenated air was accomplished with extreme difficulty.

IV. Warmth, spirits, appetite, gradually increased; debility, so productive of spasm in the language of the old school, soon disappeared: and this case, with others, tends to prove, "*that the combined powers of medicine and air may produce a good, when either, perhaps, would fail singly.*"

Mr. Roberts, oilman, No. 5, Blandford-street, whom I saw to-day, makes the following report relative to the vital air:

air. His dyspepsia had existed two years:—"From the first day inhaling the vital air, found every thing stay on my stomach: before I vomited every thing up; before, animal food took such an effect upon me, that I was obliged to leave the room where any joint was: now I eat every thing with an appetite, and, after returning from inhaling the vital air, am disposed to devour even the victuals in the street."—This patient has left off the vital air, as considering himself cured.

I have the honour to remain, yours, &c.

ROBERT JOHN THORNTON.

XXXVII. *History of Astronomy for the Year* 1803. *Read at the College de France by* JEROME DE LALANDE*.

THIS year will not appear so remarkable as the two preceding ones, in which new planets and comets were discovered; but it presents a series of important labours undertaken for the improvement of the science, either terminated or begun.

M. Piazzi has published at Palermo a very valuable work; a catalogue of nearly 7000 stars, each observed several times with excellent instruments calculated and reduced to the year 1800. It was at the *College de France* that the author, fifteen years ago, made preparations for this immense labour. We have received the catalogue of 500 stars by M. Cagnoli, with their right ascensions and declinations, which are very correct: on this work he has been employed twenty years.

Lalande my nephew, with his new aids and an immense number of his own observations, has entirely reconstructed the catalogue of 600 new stars, which for many years he has inserted in the *Connoissance des Temps*, and which serves as a foundation for the calculations of the greater part of our astronomers.

As the stars are the foundation of all our astronomical determinations, Dr. Maskelyne has carefully revised the thirty-four stars which he announced as having the utmost degree of precision, and which we have all employed, as being entitled to full confidence: he found in them an error of 4″.

The interruption of our correspondence with England during the war has induced me to undertake a very considerable labour.

* From the *Magazin Encyclopédique*, no. 15, Nivose, an 12.

I have calculated some hundreds of the sun's altitudes observed in England and France, for several years back, before and after the equinox, and have deduced from them the sun's right ascension, and consequently that of the stars which had been compared with him. I have found that it is necessary to add 5″ to the positions of the stars which Dr. Maskelyne gave us as being certain to a second, and which all astronomers employed with the greatest security: but perceiving that observations made at the distance of 40° from the zenith and at 60° gave right ascensions which differed sometimes 15″, I concluded that there were errors of division of 5″ in the interval of 20 degrees: it will therefore be necessary to recur to the whole circle, to verify the mural quadrants employed at Paris and at Greenwich.

I was at first surprised to find errors of 10″ and then of 20″ in the right ascensions; but I thought them of less consequence when I saw that from 42 to 45 degrees they were 10″, and that from 54 to 56 they amounted to 20″. The medium, therefore, between results very different is found to be the same, because the altitudes correspond at the two seasons, and the sum of the small errors compensates for that of the great.

To remedy this inconvenience in the divisions of the mural quadrant, M. Delambre this year observed the sun for two months, partly before and partly after the autumnal equinox, with a multiplying circle, and by 300 observations he had places of the sun independent of the stars. But a second in the refraction, or in the height of the pole, may occasion all the uncertainty: it will, however, be removed at the next equinox.

Picard and La Hire in the seventeenth century made the first correct observations for accomplishing this end, and the French in the present century will have made the last to attain it completely.

Herschel asserts that the stars called Castor γ of the Lion, and several other double stars very near to each other, turn round in periods of some centuries. M. Triesnecker is not of opinion with M. Flauguergues, that in the double star ζ of the Great Bear the two parts have changed: there are 14″ distance between the two stars of which it is composed.

M. Vidal has observed at Mirepois zones of the circumpolar stars which were wanting.

M. Delambre at the summer solstice made an observation of the obliquity of the ecliptic with a multiplying circle. The mean of four years observations, and of two years made by

by my nephew Lalande, gave as the mean for 1800 23° 28′: this is the result of more than 1500 observations; but it supposes the height of the pole to be 48° 50′ 13″ instead of 14″, and the latter supposes the refraction of Bradley increased by 1″. By these means he makes the winter to agree with the summer solstice, between which there was a difference of 7 or 8″. The bad weather did not permit him to observe the winter solstice with the circle which I caused to be constructed by Lenoir for the observatory of Palermo. The astronomers Bradley, Lacaille, and Mayer, found for 1750 23° 28′ 18·5″; the secular decrease, therefore, would be 42″ per century; and I prefer this result to that of the equation of the sun produced by Venus, which would give 50″.

Dr. Maskelyne found with a mural quadrant at Greenwich 23° 27′ 57″; but the English have not yet adopted our repeating circles, with which one may be certain to a second, and with which no errors in the divisions are to be apprehended.

Piazzi, at Palermo, found 23° 27′ 56·6″ with an excellent circle by Ramsden, but not a repeating circle.

The Academy of Berlin has still proposed, for 1806, the determination of the obliquity of the ecliptic, both by theory and observation. The details are contained in the Moniteur of November the first. But little remains to be done in that respect.

The refraction still contains a doubtful element; it is the correction required by the density of the atmosphere.

M. Gay has presented to the Institute an interesting memoir on this subject, and there is one in the Transactions of the Society of Manchester: an extract of it has been inserted in the *Bibliothèque Britannique* published at Geneva.

The measure of a degree of the earth in Lapland, which M. Melanderhielm has procured for us, and the calculations it required, were transmitted to us in the month of April by Messrs. Svanberg, Overbom, Holmquist, and Palander: they have found the degree to be 57197 toises. That found by Maupertuis, Clairaut, Camus, Lemonnier, Outhier, and Celsius, in 1736, was 57405, which is greater by 208 toises. This enormous difference was suspected. The degree of Lapland was at variance with all theory and with every other measurement: it gave to the earth too great a flattening; whereas the new degree gives $\frac{1}{313}$, which is not much different from the $\frac{1}{334}$ given by the new meridian of France,

compared with the degree measured in Peru. It is, however, so difficult to admit an error of such magnitude, that we have requested information from Sweden on this subject.

M. Mechain set out on the 26th of April 1803 for Spain, to continue the meridian of France to the 39th degree of latitude, that is to say, as far as the Balearian islands. He was accompanied by Mechain junior, Dezauche junior, and they were joined by M. Chaix, an able Spanish astronomer.

I gave him an excellent circle of 19 inches radius, made by Lenoir; a telescope of a large aperture was added to it: there are twelve large reverberators, and he will be able to continue his triangles to Majorca and Ivica, though at the distance of 93000 toises from the coast of Catalonia, in the months of January, February, and March, which are those most favourable for such observations. In the mean time he has formed six subsidiary triangles between Barcelona and Tortosa, as detailed in the Moniteur of November 15. But in the midst of storms and tempests, surrounded by thunder, and sleeping under a tent upon straw, he has been obliged, for the purpose of completing his operations, to cause wooden huts to be constructed on summits the climate of which is dreadful. On the 27th of October he was on the highest peaks of Montserrat for his last triangle. On the 23d of November the whole were finished; but the brig destined to carry him to the Balearian islands, having lost twenty men by the yellow fever which broke out at Malaga, was obliged to perform quarantine, and Mechain could not proceed thither, though the court of Spain had given the necessary orders. At length on the 8th of January he set out for Ivica, where he will commence his operations. It seems to be determined that the war shall not prevent this useful labour. By these means we shall have an exact measurement of 12 degrees, the mean of which will be the 45th degree, the one we are most interested to know, to verify still better our universal measure and the magnitude of the earth.

C. Chaptal, our learned minister, to whom all the arts and sciences are under daily obligations, and by whom the *College de France* has been revived, wished also to dispense to astronomy the favours of an enlightened government of which he is the organ.

The observatory has received some new acquisitions. On the 17th of August a meridian telescope eight feet long and of four inches aperture, and an axis of 46 inches, made at London by the celebrated Ramsden, was erected, and on the

the 6th of September M. Bouvard observed the moon: he observed the equinox; and these operations will not be interrupted.

The minister has purchased a dividing machine for 12,000 francs, made by Samuel Rehe: it is 43 inches, and was bought by M. Andreossi after the death of that artist. It has the same form as that of Ramsden, the description of which I translated: it will probably be of use to our artists.

The large telescope of Caroché, which is 22 feet, and equal to that of Herschel of the same length, has hitherto been useless, because it wanted a stand to support it, and a terrace to be placed on. M. Tremel, an able mechanist who made the stand, died on the 13th of February, before he could finish it. Caroché had a terrible fall in attempting to use it; so that, notwithstanding the great expense we have been at, our enjoyment is still retarded.

M. de Narcy has made prisms of rock crystal placed over each other in such a manner, that the diameters of the sun and moon can be measured by the double refraction of Rochon: father Boscovich made use of it to measure small angles.

M. Lenoir has made a circle of 20 inches for M. Piazzi of Palermo, who proposes to measure a degree: he has added to it a powerful telescope.

Government, by a decree of Vendemiaire 1st, determined that the standards of the metre and of the kilogramme, and of all the rules which have served for the different measures of the earth by the French astronomers, shall be deposited at the national observatory, under the inspection of the Board of Longitude.

The minister Chaptal has given a gratuity to M. Flauguergues, whose zeal for astronomy is still maintained at Viviers in an exemplary manner.

The minister, at my solicitation, caused also to be purchased, and deposited at the observatory, in the month of August, the observations of M. Lemonnier, which I have not had an opportunity of seeing. They consist of fourteen large volumes: the observations, which terminate at the 30th of October 1791, have been printed up to the 6th of June 1745: but it is only since the 8th of April 1755 that they were made with the mural of 7½ feet. As those of Bradley are printed only for 1750—1755, and as those of Dr. Maskelyne do not begin till the month of May 1765, there is a gap of nearly ten years; to supply which we have recourse to the observations of M. Lemonnier, though not

so correct as those of Greenwich. But Lemonnier observed more stars. I propose to unite to this deposit the observations of Picard, Louville, Lacaille, Bouguer, Bailly, and d'Agelet, which are in my hands.

M. Bouvard has made at the Luxembourg, or palace of the senate, an excellent meridian of mean time, which it is much to be wished the public would use, as is done in England and even at Geneva, and as those do who have good time-keepers by Berthoud and Breguet. Our small annuary gives the difference for each day, which amounts at most to a quarter of an hour. On the 27th of September I renewed, at the Institute, the proposal of setting the example by adopting mean time, which alone is regular, and can form a real measure.

It has been apprehended that this might be a restraint on the public, who make use of sun-dials; and the Institute has thought that government in this measure ought to take the lead by causing the clocks in the national buildings to be regulated by mean time. I do not despair of seeing adopted this new kind of exactness, which is necessary on account of the present improved state of the arts and the sciences. M. Henry Lepaute, on the 26th of December, erected in the Institute a beautiful clock, which will serve as a regulator; it indicates both mean and true time.

The astronomy of the planets has this year made some progress. M. Delambre has reconstructed tables of the sun, by introducing fourteen new equations furnished him by the theory of Laplace, and calculating 500 observations of Bradley and Maskelyne. He has increased the mass of Venus, which he employed in 1792, in the ratio of 92 to 104, and diminished that of Mars in the ratio of 100 to 72.

The tables of the moon of M. Burg have been corrected by introducing new positions of the stars, and the equation of 180 years, found by Laplace. M. Burg has found the longitude of the moon for 1801 to be $3^s\ 15^\circ\ 1'\ 17{\cdot}3'' + 10{\cdot}2'' + 0{\cdot}8''$, and the secular motion $10^s\ 7^\circ\ 52'\ 43{\cdot}5''$.

On the 1st of November M. Burckhardt presented the result of his calculations, in which he found $4{\cdot}6''$ less than the longitude given by M. Burg, whose tables come down only to the 17th of November.

L. and anom. 1801 -	$3^s\ 15^\circ\ 1'\ 12{\cdot}7''$	$0^s\ 18^\circ\ 56'\ 55{\cdot}6''$
Secular mot. - - -	10 7 52 45·5	6 18 49 17·8

The difference arises from the new equation of M. Laplace, which M. Burg, perhaps, made too small.

The eclipse of the sun which took place on the 16th of August

August was observed almost every where; it furnished us with the verification of several longitudes, and gave us a rigorous agreement in the tables.

M. Burg, who refused to come to France with an advantageous appointment, has been indemnified by a pension from the emperor.

M. Leupold, who was employed with me in observations and calculations, made preparations for observing the eclipse at Bourdeaux with M. Lescan, professor of hydrography; M. Ducom, professor of navigation; and M. Thibaut, a captain in the navy: but the weather was not favourable.

I have made new tables of Mercury and Venus, by employing the perturbations or inequalities produced by the attraction of the other planets. M. de Laplace had given the equations estimated by M. Bouvard.

M. Burckhardt calculated the tables. I corrected the elements according to the latest observations, and I have had the satisfaction to see that the new ones are so exact that no errors of any consequence can be found in the most correct observations of Mercury and Venus.

M. Flauguergues has calculated the equation of Mercury in tenths and seconds, and the logarithms to eight places.

The following is the last inferior conjunction of Venus, observed at Paris by Burckhardt and Lalande my nephew:

Mean time of the true conjunction December 31st, 3^h $15' \, 3''$; and the true longitude, counted from the mean equinox, $9^s \, 9^\circ \, 19' \, 5''$.

It gives for the correction of the present tables, $-\,13''$ in longitude, and $-\,1''$ in latitude; but by means of the correction which I made in the epochs and mean motions there remains only $1''$ of error for the longitude. I find in 1795, $1''$; in 1796, $2''$; in 1798, $1''$; in 1799, $1''$; in 1801, zero: which proves that there is no change to be made in the new elements.

In the digression of March 13, 1803, M. Flauguergues found $+\,21''$ and $+\,4''$.

In the month of May 1804 Venus will astonish the public by her great splendour; and we shall be obliged to announce in our journals, that she is not a new star, nor an extraordinary comet.

The opposition of Mars at the end of 1802 $-\,6''$ in longitude, $+\,2''$ in latitude, for the tables which Lalande my nephew published in the *Connoissance des Temps* for the year 12, 1804.

M. Bouvard has reconstructed the tables of Jupiter according to observations made for ten years, employing

equations of conditions which give the means of verifying all the elements. He has brought them to such perfection that the errors amount only to 10″; but the mass of Saturn, reduced to $\frac{1}{3516}$, is more exact than that deduced from the satellites.

The opposition of Jupiter gives — 2″ in longitude.

The opposition of Saturn in the month of March gave for the correction of the tables in longitude — 17″, and in latitude zero. But M. Bouvard will undertake the same labour in regard to Saturn as that which he has announced on Jupiter.

The disappearance of Saturn's ring, according to the calculations of Dusejour, will not take place till the end of June.

For the end of December he found only an almost disappearance, or an instantaneous disappearance*; a tendency to disappear †. But the disappearance was complete from the 20th of December to the 10th of January, according to M. Mechain and M. Flauguergues, at Viviers. I have thence deduced the place of the node of Saturn's ring in the ecliptic $5^s\ 17°\ 11'$; the observations of 1774 gave $5^s\ 17°\ 29'$: the difference is small, and makes only 18′ in twenty-nine years for the motion of the node of the ring. I found still less for the anterior disappearances ‡.

The reappearance took place on the 14th of June, according to M. Flauguergues.

On the 16th, according to M. Vidal; and the result was nearly the same.

Among the rare observations which M. Vidal has sent us, there is one very extraordinary. On the 11th of October he observed Jupiter and Venus at the same time as the limb of the sun: they differed only 10′ in declination: he saw them together in the field of the telescope. He observed Saturn in the meridian 20′ before the sun.

Olbers's planet, discovered on the 28th of March 1802, has this year afforded occupation to all the astronomers. It had been lost since the 16th of October 1802; we were all impatient to see it again: M. Harding, of Lilienthal, first enjoyed this satisfaction; on the 19th of February he saw it like a star of the twelfth magnitude.

M. Messier followed it till the month of September, notwithstanding the extreme difficulty of seeing it with the best telescopes.

Messrs. Burckhardt and Lalande my nephew observed

* Vol. ii. p. 124. † Page 155. ‡ Astron. art. 3355.

it

it at the Military School, or *Maison du Champ de Mars*, as long as it could be seen on the meridian. They found the opposition on the 29th of June 1803 at 23^h $57'$ $10''$ mean time in 9^s 7^o $39'$, with 46^o $26'$ $36''$ of latitude.

On the 11th of July M. Burckhardt gave us the new elements, by which we can find it again in the month of March next.

The sidereal revolution, 1681 days $\frac{28}{100}$; tropical revolution 1680·97, or 4 years 7 months 11 days.

Semi-axis - - -	2·767123
Aphelion - - -	4^s 1^o $6'$ $46''$
Node - - -	5 22 27 35
Inclination - -	0 34 38 50
Anomaly, June 30 - -	10 19 9 0

Which gives for the mean longitude the 1st of January 1804, 9^s 29^o $52'$ $58''$; eccentricity the same as in the preceding elements, 0·2463; diurnal motion, $12'$ $50·983''$; annual motion, 78^o $10'$ $9''$.

M. Burckhardt has been employed in calculating the perturbations experienced by the planets of Piazzi and Olbers. In consequence of the attraction of Jupiter these calculations are exceedingly complex, because the higher powers of the eccentricity and inclination produce a great number of terms.

He has given formulæ of the perturbations to the 5th power; and he even believes that the eleventh power might furnish sensible terms for that of Olbers. He is engaged in these researches.

On the 18th of Thermidor of the year 11, according to the *senatus consultum* of the 26th of Vendemiaire preceding, government admitted M. Burckhardt to the privileges of a French citizen. Want of this admission prevented him from being a member of the Institute at the last election. Government wished to indemnify him by a flattering distinction due to exalted merit. This is a new encouragement to the labours with which he daily enriches astronomy.

On the 4th of April the Institute decreed, for the first time, the prize of astronomy which I founded the preceding year. It was adjudged to Dr. Olbers for his discovery of a tenth planet.

I see with regret, that the Germans have no more respect for Dr. Olbers than they have for Dr. Herschel. The name of Pallas has no foundation: jealousy, perhaps, is the cause of this injustice.

I have had the satisfaction to find that astronomy is extending

tending even in America. Don Antonio de Robredo has sent me from the Havannah minute calculations of the eclipse of the sun, on the 10th of February 1804, made by the analytical methods of M. Dusejour, for every country of the earth, with all the dimensions of the curves of illumination. These calculations, more extensive and more exact than those in the *Connoissance des Temps* for the year 12, arrived too late to be inserted in that work; which I much regretted.

The French government has resolved to re-establish the mission to China, which is equally useful to the sciences and to political relations. One of our ablest astronomers has formed the project of going thither; and however great his utility may be here, I did not oppose this plan of going to a distance from us, in order that he may still be of more service to us.

The duke of Brunswick has resolved to cause an observatory to be constructed. Baron von Zach has been at Brunswick for that purpose; and I have thanked, in the name of all astronomers, the prince who increases the number of heroes, protectors of astronomy, whom I have mentioned in the preface to my work on that subject.

The Italian republic has requested an astronomer to cooperate with M. Ciccolini in the observations made in the Institute of Bologna.

M. Vassalli-Eandi has requested that the observatory of Turin may be put into a state of activity.

The margrave of Baden, having taken possession of Manheim on the 23d of November 1802, preserved the instruments of the observatory; and M. Bary has announced to me a new series of observations.

My *Bibliographie Astronomique* appeared on the 5th of June in a quarto volume of 900 pages. It contains as large a catalogue, as I was able to make, in the course of thirty years, of all the astronomers and all the works on astronomy which have appeared for two thousand years.

Bailly's large History of Astronomy terminated at 1781: I have continued it to the end of 1802.

M. Goudin has given a new edition of his Astronomical Memoirs.

On the 17th of March the Board of Longitude published the *Connoissance des Temps* for the year 13, which contains every thing relating to astronomy that has been done in the countries where it is cultivated: the history and observations of the new planets and of the last comets; a new catalogue, which makes the number of the stars known to be 13,000;

13,000; memoirs and observations by baron von Zach and M. Ciccolini, Delambre, Mechain, Vidal, Flauguergues, Goudin, Sorlin, Lalande uncle and nephew, Burckhardt, Nouet, Chabrol de Murol, and Thulis; with the History of Astronomy for the years 8 and 9, to serve as a continuation of that given for the preceding years since 1782.

The *Connoissance des Temps* for the year 14 is on the point of appearing: it contains all the calculations of the moon made from our new tables for the use of the navy, with a great number of observations, tables, and memoirs, by Laplace, Delambre, Vidal, Herschel, Messier, Burckhardt, Lalande uncle and nephew, Olbers, Thulis, Flauguergues, and Duc-la-Chapelle; the history of astronomy for 1802; supplements to my *Bibliographie*; tables of aberration for 140 stars, a twelfth catalogue of new stars, a table of the changes in longitude and latitude for 600 principal stars, the measurement of the degree in Lapland, and a table of all the articles contained in the forty-five last volumes of the *Connoissance des Temps* since 1760, when I began to keep a register of the annual progress of astronomy.

M. Legendre has given to the Institute a new formula for the reduction of the apparent distances, with tables for simplifying the use of them: there are already a great number: we shall have an opportunity of choosing that which appears the easiest and shortest.

M. de Laplace has given in the *Bulletin* a theory of the deviation of falling bodies, in consequence of the experiments of M. Guglielmini and Henzenberg. The result is, that the deviation ought to be null towards the south, though M. Guglielmini found it to be three lines. But these experiments are so difficult to be made, and the resistance of the air so little known, that this does not impeach the results of M. Guglielmini.

The Ephemerides of Milan for 1802 contain observations of Mercury; of the occultation of the Spica Virginis on the 30th of March 1801; tables of the annual parallax of Mars, of the precession of the stars, and of the motion peculiar to a great number of them.

Those of 1803 contain the perturbations of Piazzi's planet by M. Oriani, and observations of that planet and of that of Olbers.

M. Laurent Regnier, professor of astronomy at Upsal, has published a dissertation *De Massis Cometarum*.

The Ephemerides of Vienna for 1804 contain observations of different places by M. Triesnecker and M. Burg. The

The latter gives a series of observations of the moon, which may serve to verify his tables.

On the 24th of September 1803 we received the tenth volume of the Transactions of the Italian Society, which contains a valuable catalogue of the stars by M. Cagnoli; the opposition of Herschel in 1791 by Slop and oppositions of Mars by Chiminelli, at Padua, in 1790, 1792, and 1794.

The Society of the Sciences at Warsaw has published a volume of memoirs, in which there are observations by M. Sniadecki.

On the 24th of October 1803 we received the Memoirs of the Academy of Sciences at Berlin for 1799 and 1800, in which there are anecdotes for the History of the Mathematics by Bernoulli; the pendulum which swings seconds at Berlin, by M. Burja, 3 f. 2 in. 0·24 lines; a memoir on the problem of the precession of the equinoxes, by the formulæ of Lagrange, by M. John Trembley; and astronomical observations 1798—1800 by M. Bode.

My small stereotype tables of logarithms, the most exact, most convenient, and cheapest ever published, have been again collated by M. Bubna: no faults were found in them; and I announced that I would give a hundred francs for each fault which might be discovered.

Besides the interesting journal of baron Von Zach, entitled *Monatliche Correspondenz der Erde und Himmelkunde*, there is one at Weimar entitled *Algemeine Geographische Ephemeriden*, by Gaspari and Bertuch: the number for February 1803 contains an engraving of the celebrated astronomer Joseph Nicholas de l'Isle, from a painting at Paris in the possession of Messier.

We have received the Memoirs of the Academy of Petersburgh for 1795 and 1796, in which there are observations of Henry; memoirs by Schubert on the theory of the moon and on the transits of Mercury; one by M. Rumouski on the figure of the earth; two by M. Kraft on nautical astronomy; and one by M. Inochodzof on the heights of several places observed by the barometer.

M. Novoziltzoff, president of the academy, has caused to be placed in the observatory a beautiful transit instrument, which he purchased from Ramsden during his residence at London. On the 25th of July he obtained an increase of the funds of the academy.

M. Wisniewski, of Warsaw, has been invited to Petersburgh on the recommendation of professor Bode, whom he assisted. He arrived there on the 1st of August, and began his

his labours in the observatory with great zeal. The president expects to draw to Petersburgh an astronomer of reputation.

Hitherto we have seen no native of Russia distinguish himself in that country by astronomy. But I experienced an agreeable surprise, and entertain consoling hopes, when I see young Alexander Oulibisheff, at the age of ten, converse with me on astronomy in a manner I never before witnessed, even in France, from persons of twenty years of age. He was born at Moscow on the 27th of November 1793.

The emperor of Russia, in the new statutes of the imperial university of Vilna, issued on the 8th of May, ordered that there shall be an observer and professor of astronomy. M. Poczobut, who has long resided there, is a pledge that our science will not be neglected.

M. Sniadecki, a Polish astronomer, formerly of Cracow, not having been able to obtain from the Austrian government the necessary assistance for that observatory, has preferred the observatory of Vilna, where he will assist M. Poczobut.

M. Honoré Ponz, an ingenious clockmaker, whose excellent clocks I have announced, has this year made an important improvement by adding free escapements, which are ingenious, and which by means of *remontoirs* leave no room for the inequalities of *rouage* to affect the motion of the pendulum. He presented a description of it to the Institute on the 12th of December.

[To be continued.]

XXXVIII. *A Letter to Governor* Pownall *from Dr.* Thornton.

April 16, 1804,
No. 1, Hinde-street,
Manchester-square.

SIR,

I was pleased to find a gentleman of your sound judgment, matured by the enjoyment of long life, chiefly consecrated to science, observing the changes of men and things, recalling the philosophic world to the sentiments entertained by our forefathers. When Dr. Priestley made his discoveries in chemistry, like John Hunter he disclaimed all the advantages of reading; and the French chemists, catching at the seemingly new lights he threw out, formed a brilliant system which went to acknowledge no authorities

ties but their own. You, sir, even in the new science of galvanism, have advanced the sentiments of Sir Isaac Newton; and in this letter I shall extract from a very scarce work, entitled A Treatise on the Animal Economy, by Dr. Bryan Robinson, (published in 1734, in Dublin, the second edition,) some passages which show the advances then made in chemistry and the animal œconomy. In the preface this learned writer says: "Harvey, from experiments and observations, traced out the circular motion of the blood. After him Lower made some further discoveries concerning that motion, and the causes by which it may be disturbed. After these great men, the knowledge of the animal œconomy received no very considerable improvement till Sir Isaac Newton discovered the causes of muscular motion and secretion; and likewise furnished materials for explaining digestion, nutrition, and respiration. To him I am chiefly indebted for what I have delivered on those heads."

He then goes on, in a most ingenious and satisfactory train of deep reasoning, to establish very curious and interesting propositions respecting the motion of the blood, in twenty-three propositions, and then proceeds to

Proposition xxiv.—"*The life of animals is preserved by acid parts of the air mixed with the blood in the lungs; which parts dissolve or attenuate the blood, and preserve its heat; and by both these keep up the motion of the heart.*

"I shall prove the truth of this proposition from a series of experiments and observations.

"*First*, then, animals die when they are deprived of air by stopping the wind-pipe, or putting them in an air-pump and drawing out the air. And they likewise die soon in a small quantity of air so closely confined as to have no communication with the rest of the atmosphere: small birds cannot live above three or four hours in a quart of such air; and a gallon of air included in a bladder, and by a pipe alternately inspired and expired by the lungs of a man, will become unfit to preserve life in little more than one minute of time.

"Hence it appears that air is necessary to preserve the life of animals; and likewise, that a constant supply of fresh air is necessary to that end.

"*Secondly*, A candle goes out, glowing coals and red-hot iron cease to shine, and animals die, in the air-pump on drawing out the air. A candle goes out, glowing coals and red-hot iron cease to shine, and animals die, in a small quantity of air so closely confined as to have no communication with the rest of the atmosphere. Animals die in air rendered

rendered effete by burning coals or candles in it till they are extinguished, and glowing coals or candles are extinguished in air rendered effete by animals breathing in it till they die. Hook found, that if air rendered effete be blown on live coals, it produces no other effect than to blow off the ashes and put out the fire; and that the more you blow, the more dead is the light, and the sooner is the fire quite extinct; insomuch that in a very little time the coals become perfectly black, without emitting the least glimpse of light or shining: at which time if one blast of fresh air be blown upon those seemingly dead, extinct, and black coals, they all begin to glow, burn, and shine afresh, as if they had not been at all extinct; and the more fresh air is blown upon them, the more they shine, and the sooner are they burnt out and consumed: and animals put into such effete air soon die, though for some time they breathe and move their lungs as before. The medium found in damps is present death to those who breathe it, and in an instant extinguishes the brightest flame, the shining of glowing coals, or red-hot iron, when put into it. Common air, by passing through red-hot brass, red-hot iron, red-hot charcoal, or the flame of spirit of wine, becomes unfit to preserve life, and the shining of fire and flame.

"Hence it appears that fresh air preserves life in animals by the very same power, or by the operation of the very same parts, whereby it preserves fire and flame in sulphureous and unctuous substances when once they are kindled.

"*Thirdly*, If two parts of compound spirit of nitre be poured on one part of oil of cloves or caraway seeds, or of any ponderous oil of vegetable or animal substances, or oil of turpentine thickened with a little balsam of sulphur, the liquors grow so very hot in mixing, as presently to send up a burning flame: if a drachm of the same compound spirit be poured upon half a drachm of oil of caraway seeds, even *in vacuo*, the mixture immediately makes a flash like gunpowder: and well rectified spirit of wine poured on the same compound spirit flashes. Common sulphur and nitre powdered, mixed together, and kindled, will continue to burn under water, or *in vacuo*, as well as in the open air.

"Now, since air is necessary to preserve common fire and flame in sulphureous and unctuous substances when once they are kindled, (and it appears by these experiments that fire and flame may both be produced and preserved in sulphureous and unctuous substances by acid particles even without

without air,) it follows that air preserves fire and flame by means of acid particles; and since it preserves the life of animals by the operation of the very same particles whereby it preserves fire and flame, it likewise follows that it preserves the life of animals by its acid particles.

"*Fourthly*, The venal blood is of a deep purple colour, and the arterial blood of a bright red, in all parts of the body except the lungs; and in them the blood is of a dark purple colour in the pulmonary artery, and of a bright red in the pulmonary vein. Hence it follows that the blood changes its deep purple colour into a bright red in the communicant branches of the pulmonary artery and vein which are spread on the vesicles, and that it changes its bright red into a deep purple colour in the communicant branches of the arteries and veins of other parts. If blood be drawn out of a vein, its surface, which is contiguous to the air, will acquire the same bright red colour which the blood acquires in the lungs; and if this red surface be cut off with a sharp knife, the blackish surface of the remaining blood, being now touched and acted upon by the air in the same manner as the first, will acquire the same colour as that did; and the same change of colour will be made in the bottom of the cake, if it be turned upwards in the cup, and exposed to the air; and if blood just drawn be stirred and agitated till the air be intimately mixed with it throughout, its whole substance will soon acquire the bright red colour of arterial blood. If the windpipe be stopped with a cork, and some time after the operation (when the air which is shut up in the lungs is made effete, that is, deprived of its acid parts) blood be drawn from the cervical artery, it will have the same dark purple colour as venal blood.

"Now, since from these experiments the air must touch venal blood drawn out of the body to change its deep purple colour into a bright red, and the acid parts of the air cause the same change of colour in the blood in the lungs, it will follow that there must be a like contact of these acid parts with the blood in the lungs: and since I have shown that air preserves the life of animals by its acid parts, it will likewise follow that the life of animals is preserved by acid parts of the air mixing with the blood in the lungs.

"*Fifthly*, The bright red colour acquired by the blood in the lungs, from its purity and intenseness, is the red of the second order of colours in the table of Sir Isaac Newton's Optics, p. 206: but the blackish or deep purple colour of venal blood turns into this bright red without passing through the colours of blue, green, yellow, and orange, and

and therefore must arise from the indigo and purple of the third order, and not from the indigo and violet of the second; and consequently by that table the tingeing corpuscles of the blood are lessened in the lungs.

"Hence it appears that the acid parts of the air dissolve or attenuate the blood in the lungs.

"Oil of vitriol and water poured successively into the same vessel grow very hot in the mixing: *aquafortis*, or spirit of vitriol, poured upon filings of iron, dissolves the filings with a great heat and ebullition: and the acid of the air constantly applied to sulphureous and unctuous substances, when once they are kindled, continues to dissolve them with the heat of fire and flame.

"From these experiments we learn, that it is the nature of acids to dissolve bodies with heat; and therefore, since I have shown that the acid of the air dissolves the blood, it must be allowed that it warms the blood at the same time it dissolves it.

"When animals are deprived of the acid of the air, the pulse in less than one minute of time becomes small and quick; as may be observed in a dog, when his lungs are made flaccid and without motion by laying open his thorax. Upon emptying my lungs of air as much as I could, and then stopping my breath, my pulse has grown small and quick, with a kind of trembling convulsive motion, in less than half a minute of time. And Thurston observed the pulse to grow smaller on an intermission of respiration, and greater again on repeating it.

"Hence it appears that the motion of the heart lessens immediately on animals being deprived of the acid of the air; and consequently that this acid, by dissolving or attenuating the blood and preserving its heat, keeps up the motion of the heart.

"Therefore the proposition is true.

"*Scholium.*

"1. The motion of the lungs in breathing is no otherwise necessary to the life of animals, than as by this motion the lungs receive a constant supply of fresh air.

"For Hook, after he had laid open the thorax of a dog, cut away his ribs and diaphragm, and taken off the pericardium, kept him alive, before the Royal Society of London, above an hour, by blowing fresh air into his lungs with a pair of bellows. It was observed, that as often as he left off blowing, and suffered the lungs to subside and lie still, the dog presently fell into dying convulsive motions, and soon recovered again on renewing the blast. After he had done this several times with like success, he pricked all

the outer coat of the lungs with the slender point of a sharp penknife, and by a constant blast made with a double pair of bellows he kept the lungs always distended and without motion; and it was observed, that while the lungs were thus kept distended with a constant supply of fresh air, the dog lay still, his eyes were quick, and his heart beat regularly; but that upon leaving off blowing, and suffering the lungs to subside and lie still, the dog presently fell into dying convulsive motions, and as soon recovered again on renewing the blast, and supplying the lungs with fresh air.

"2. The motion of the lungs in breathing does not change the colour of the blood in that part.

"For Lower, on opening the pulmonary vein of a dog near the left auricle of the heart, when his lungs were kept distended and without motion by a constant supply of fresh air, observed the blood drawn to have the same florid colour as the arterial blood of other parts.

"Further, if the motion of the lungs changes the colour of the blood from a dark purple to a bright red, I see no reason why the motion of the muscles, when continued for some time, should not keep up that red colour in the veins; and consequently, why, under strong exercise, venal blood, contrary to experience, should not be of a bright red colour. For a strong and vigorous motion of the muscles must undoubtedly contribute as much to preserve the bright red colour of arterial blood, as the motion of the lungs contributes to produce it.

"3. The death of animals and extinction of flame in a confined air are not caused by a diminution of its elasticity.

"For there is sometimes as great a diminution of elasticity in the air in violent storms of wind, and hurricanes, as there is in a small quantity of confined air at the time when animals die, and candles go out in it, and yet no such effects follow. Further, if animals die and candles go out in a confined air from a diminution of its elasticity, then these effects would not be produced in different quantities of confined air until its elasticity was equally diminished in them; but it has been found by experiments, that at the time when animals die and candles go out in two different quantities of confined air, there is a greater diminution of elasticity in the smaller quantity than in the greater: and therefore life and flame are not destroyed by a diminution of the elasticity of the air. This is further confirmed from an experiment mentioned above; for if effete air, however forcibly blown on live coals, extinguishes them in like manner as it does when in a state of rest, then the same effete air, which in a quiescent state cannot preserve life, will not be

be able to do it when it is pressed into the lungs with any force, even a greater than is sufficient to swell the air-vessels to their usual magnitudes: and therefore animals do not die in a confined air, from the *vesiculæ* not being sufficiently dilated on account of a diminution of the elasticity of the air. A diminution of the elasticity of the air is no otherwise hurtful than as it hinders the vesicles from being sufficiently dilated, and thereby hinders the blood from receiving its usual quantity of acid in a given time; on which account the blood will not be sufficiently dissolved and warmed in the lungs; which will make respiration quick and uneasy, but cannot cause sudden death."

His xxviith Proposition is,—" *The nourishment of animals changes its texture in their bodies till it becomes like their solid and durable parts.*

" For the solid and durable parts of animal bodies grow out of their nourishment; but their growth is from an addition and adhesion of like parts, and therefore the nourishment of animals changes its texture in their bodies till it becomes like their solid and durable parts.

" *Cor.* 1. Hence it appears that animals will not be rightly nourished when their nourishment does not change its texture in their bodies till it becomes like their solid and durable parts.

" *Cor.* 2. Hence it appears that the nourishment, by changing its texture in the bodies of animals, becomes more dry and earthy than it was before, otherwise it would not be like their solid and durable parts.

" Proposition xxviii.—*The texture of the nourishment is changed in the bodies of animals by a gentle heat and motion.*

" The first remarkable change in the texture of the nourishment is made in the stomach: in this bowel the solid parts of the food are dissolved and intimately mixed with the fluids. This mixture is usually called *chyle.*

" Some, from observing that fluids have a power of dissolving bodies, have thought that a fluid in the stomach dissolves the food and turns it into chyle; but as it does not appear from experiments and observations that there is a fluid in the stomach endued with such a power, this opinion is without foundation.

" Others, from observing the great strength of the gizzards of fowls, and that there is commonly gravel found in them, have imagined that the food is dissolved in the stomachs of fowls, and consequently in the stomachs of all animals, by attrition or grinding. But if this opinion be examined, it will likewise appear to be without foundation: for the food of fowls is mostly grain, all sorts of which are

hard and covered with tough skins; and therefore before this food can be dissolved and turned into chyle, it must be softened and its skins ground off; the first of which is done by warmth and moisture in the craw, and the second by attrition in the gizzard. By these contrivances the food of fowls is prepared and fitted for digestion, as human food is by cookery and other ways of preparing it, and by the grinding of the teeth. But if we should grant that the food of fowls is dissolved and turned into chyle by attrition, it will by no means follow that food is so dissolved and turned into chyle in a human stomach, which has no gravel in it, and has but very little muscular strength in comparison of the gizzards of fowls. There may be many different contrivances in different species of animals, to soften, grossly divide, and prepare their food for digestion; but it will not from thence follow that their food is digested or turned into chyle by different causes.

"The food is dissolved and turned into chyle by a gentle heat and motion. Heat makes many bodies fluid which are not fluid in cold. Lead is melted by a heat eight times as great as the external heat of a human body; tin, by a heat six times as great; wax, by a heat twice as great; and bones, with the addition of a little water, are dissolved in a digester by heat in a little time. If the heat of the stomach be nearly equal to that of the blood, it may be sufficient, when the orifices of the stomach are pretty exactly closed, to dissolve the food in a few hours, and turn it into chyle; especially when it is assisted by the motion of the stomach, which by agitating and mixing the food will contribute to this end. For, since heat can dissolve solid bodies, and nothing is found in a human stomach, besides a gentle heat and motion, which can dissolve the food and turn it into chyle, it will follow that the food is digested or dissolved, and turned into chyle, by a gentle heat and motion.

"The chyle in moving through the intestines is further dissolved by heat and motion; and the finest part of this fluid being conveyed into the blood, is still further changed by the same causes, namely, a gentle heat and motion, till it puts on the form of blood, and, at last, becomes fit to nourish the body by being made like its solid and durable parts. The growth of the chicken in the shell out of the white of the egg is a strong proof of the truth of this: for here is manifestly nothing, besides a gentle heat and motion, to change the white of the egg so as to convert it into blood, and render it fit nourishment for all the parts of an animal body.

"*Cor.* Hence animals will not be rightly nourished when the

the texture of their food is not rightly changed in their bodies by heat and motion; which may be owing either to an unfitness in the food for such a change, or to degrees of heat and motion unfit to effect it.

"Proposition xxix.—*The constituent solid parts of animals, according to their several natures, are endued with peculiar attractive powers of certain magnitudes or strengths, by which they draw out of the fluids moving through them like parts in certain quantities, and thereby preserve their forms and just magnitudes.*

"For, without attractive powers agreeable to their natures, the constituent solid parts of animals cannot draw like particles out of the fluids moving through them, and consequently cannot preserve their forms; and unless these powers be of certain strengths, they cannot draw those parts in such quantities as are proper to preserve their magnitudes: and therefore the proposition is true.

"*Cor.* 1. Hence bodies will not be rightly nourished by proper food, changed by just degrees of heat and motion, when the attractive powers of their solid parts are changed either in their natures or in their magnitudes.

"*Cor.* 2. Hence animals of the same species will grow faster or slower out of the same nourishment rightly changed by heat and motion, as the attractive powers of their solid parts are stronger or weaker: and universally their growth in a given time will be greater or less, as the attractive powers of corresponding parts are greater or less; or as the fluids moving through those parts abound more or less with similar particles, that is, with particles rightly fitted to be attracted by those powers.

"*General Scholium.*

"I have shown that the nourishment of animals becomes more dry and earthy in their bodies, and that this change is effected by a gentle heat and motion. How a gentle heat and motion cause this change in the nourishment, may be understood from what Sir Isaac Newton has delivered concerning the nature of salt. This great man, finding from experiments and observations that salts are dry earth and watry acid united by attraction, and that the earth will not become a salt without so much acid as makes it dissolvable in water, has given the following account of the formation of particles of salt:

"'As gravity makes the sea flow round the denser and weightier parts of the globe of the earth, so the attraction may make the watry acid flow round the denser and compacter particles of earth for composing the particles of salt:

for otherwise the acid would not do the office of a medium between the earth and common water, for making salts dissolvable in water; nor would salt of tartar readily draw off the acid from dissolved metals, nor metals the acid from mercury. Now, as in the great globe of the earth and sea the densest bodies by their gravity sink down in water, and always endeavour to go towards the centre of the globe, so in particles of salt the densest matter may always endeavour to approach the centre of the particle: so that a particle of salt may be compared to a chaos, being dense, hard, dry, and earthy in the centre; and rare, soft, moist, and watry, in the circumference. And hence it seems to be that salts are of a lasting nature, being scarce destroyed, unless by drawing away their watry parts by violence, or by letting them soak into the pores of the central earth by a gentle heat in putrefaction, until the earth be dissolved by the water and separated into smaller particles, which by reason of their smallness make the rotten compound appear of a black colour. Hence also it may be that the parts of animals and vegetables preserve their several forms, and assimilate their nourishment; the soft and moist nourishment easily changing its texture by a gentle heat and motion, till it becomes like the dense, hard, dry, and durable earth in the centre of each particle. But when the nourishment grows unfit to be assimilated, or the central earth grows too feeble to assimilate it, the motion ends in confusion, putrefaction, and death.'"—*Newt. Opt.* p. 361, 362.

"Hence it appears that to render the saline part of the aliment fit to nourish the solid parts of animals and vegetables, part of the superficial watry acid must by heat and motion be drawn off from the particles of salt, by which they will become more dense, hard, dry, and earthy, like the solid and durable parts of the bodies: and, according to the different degrees of heat and motion in the different species of animals and vegetables, the watry moisture will be drawn off in different proportions, so as in each species to render the particles like the solid parts of the bodies of that species.

"And further, if we consider that water is a very fluid tasteless salt, and that animals and vegetables, with their several parts, grow out of water and watry tinctures and salts, we may, from what has been said, understand the manner in which the nourishment of animals and vegetables is changed by a gentle heat and motion till it become like the solid and durable parts of their respective bodies.

"Proposition xxx.—*The glands in the bodies of animals, according*

according to their several natures and dispositions, are endued with peculiar attractive powers by which they suck in various juices from the blood.

"That the glands of animals have such attractive powers, I shall prove from experiments and observations:

"'If two plane polished plates of glass (suppose two pieces of a polished looking-glass) be laid together, so that their sides be parallel and at a very small distance from one another, and then their lower edges be dipped into water, the water will rise up between them. And the less the distance of the glasses is, the greater will be the height to which the water will rise. If the distance be about the hundredth part of an inch, the water will rise to the height of about an inch; and if the distance be greater or less in any proportion, the height will be reciprocally proportional to the distance very nearly. The weight of the water drawn up being the same, whether the distance between the glasses be greater or less, the force which raises the water and suspends it must be likewise the same, and suffer no change by changing the distance of the glasses. And in like manner, water ascends between two marbles, polished plane, when their polished sides are parallel and at a very little distance from one another. And if slender pipes of glass be dipped at one end into stagnating water, the water will rise up within the pipe, and the height to which it rises will be reciprocally proportional to the diameter of the cavity of the pipe, and will equal the height to which it rises between two planes of glass, if the semi-diameter of the cavity of the pipe be equal to the distance between the planes, or thereabouts. And these experiments succeed after the same manner *in vacuo* as in the open air, (as hath been tried before the Royal Society,) and therefore are not influenced by the weight or pressure of the atmosphere.'"—See *Newt. Opt.* p. 366, 367.

"Now, since the rise and suspension of water between two glass planes, and in small glass pipes, are not owing to the pressure of the atmosphere, they must be caused by an attractive power in the glass proportional to the weight of water sustained by it. Let H,h denote the heights of the column of water sustained between the two glass planes and of the cylinder sustained in a small glass pipe; B,p the breadth of the column and periphery of the cylinder; and D,d the thickness of the column and diameter of the cylinder: and then the attractive power which sustains the column will be as HBD, or as B, because H is as $\frac{1}{D}$; and

 the

the attractive power which sustains the cylinder will be as $\frac{hpd}{4}$, or as $\frac{p}{4}$, or as p, because h is as $\frac{1}{d}$.

"Hence it appears that the attractive power which sustains the water arises only from those parts of the glass which are contiguous to the surface of the elevated water; or, more truly, from the parts of a narrow surface of the glass, whose lower edge touches the surface of the water, and whose height is the small given distance to which the attractive power, with which glass attracts water, reaches; and therefore the attractive powers of the glass planes and small glass pipe will be as 2 B and p. But the powers are as the weights sustained by them, that is, 2 B. p :: HBD. $\frac{hpd}{4}$: whence HD will be equal to $\frac{hd}{2}$; and, when D is equal to $\frac{d}{2}$, H will be equal to h.

"This power varies in one and the same pipe, or becomes different when exercised on different fluids. For one and the same small glass pipe will sustain different weights of different fluids, as appears from this table.

Fluids.	Heights in Inches.	Densities.	Weights.
Oil of Vitriol	1·1	17245	18969
Water p. 6. Sal Gem p. $\frac{3}{4}$	1·73	10921	18893
Water p. 6. Sal Gem p. $\frac{1}{2}$	1·72	10642	18304
Water p. 8. Common Salt p. $\frac{1}{2}$	1·67	10447	17446
Water p. 6. Salt-petre p. $\frac{1}{2}$	1·71	10447	17864
Spirit of Vitriol	1·63	11860	19331
German Spa Water	1·75	10111	17694
Common Water cold	1·75	10000	17500
Common Water boiling hot	1·64	9781	16040
Good Blood	1·64	10400	17056
Serum of good Blood	1·65	10300	16995
Serum in a Dropsy	1·65	10171	16782
Urine	1·60	10270	16432
Saliva	1·54	10100	15554
Milk of a Cow	1·42	10279	14596
Gall of an Ox	1·2	10335	12402
Small Beer	1·44	10111	14559
Cyder	1·3	10111	13144
Vinegar	1·23	10279	12643
Common Ale	1·2	10300	12360
Red Wine	1·15	9930	11419
Punch	1·12	10055	11261
Oil Olive	1·14	9130	10408
Oil of Turpentine	0·81	9244	7487
Sal Volatile Oleosum	0·84	8774	7370
Brandy	0·75	9320	6990
Spirit of Wine rectified	0·73	8324	6076
Spirit of Hartshorn	1·44	9802	14114

"In

"In the first column are the names of the fluids; in the second, the heights to which they rose in one and the same glass pipe; in the third, the densities of the fluids; and in the fourth, the weights sustained by the same pipe. I obtained the weights by multiplying the heights into the densities: for the weights of cylinders are as their magnitudes and densities taken together, or as their heights and densities taken together if their bases be equal; but the bases of all the cylinders of different fluids sustained by one and the same pipe are equal, and therefore the weights of such cylinders are as their heights and densities taken together.

"Hence it appears that one and the same glass pipe attracts different fluids with different degrees of force. It attracts spirit of vitriol more strongly than oil of vitriol, oil of vitriol more strongly than water impregnated with salt, water impregnated with sal gem and nitre more strongly than common water cold; common water cold, more strongly than the animal fluids and common water made boiling hot; the animal fluids more strongly than fermented liquors; fermented liquors more strongly than oils; and oils more strongly than ardent spirits.

"So then, if equal quantities of all the fluids of this table were mixed together, the same glass pipe would suck in different parts of this heterogeneous fluid in different proportions. It would suck in more parts of water impregnated with salt than of oil or ardent spirits. The parts least attracted would be driven off, to make way for those which are most attracted to enter into the pipe; as in a fluid where the force of gravity alone takes place, the lighter bodies are forced to ascend, to make way for the descent of bodies which are heavier.

"Sir Isaac Newton has proved from experiments, that the particles of light attract ardent spirits and oil more strongly than water; and by consequence, if we suppose a small pipe to be formed out of particles whose attracting powers are the same with those of the particles of light, and one end of it to be dipped into a heterogeneous fluid composed of equal quantities of all the fluids of this table intimately mixed together, such a pipe would attract the parts of oil and ardent spirits more strongly than those of water, and suck in more parts of the two former than of the latter. The fluid, therefore, drawn out of the heterogeneous fluid by this pipe, would be different from the fluid drawn out of it by a small glass pipe; for two fluids will be different, when they either consist of different parts, or of the same parts mixed in different proportions.

"Now,

" Now, since pipes of different natures draw off different fluids from one and the same heterogeneous fluid, it follows, that the secerning pipes of the glands, according to their different natures and dispositions, suck in various juices from the blood, which is a heterogeneous fluid consisting of a great variety of parts: and, consequently, the proposition is true."

This work, which contains 338 pages, shows how much the knowledge of the animal œconomy was advanced in those days, and how great a genius Sir Isaac Newton was, and the prevalency of his opinions, now almost passed by in oblivion. And in a second letter, for this, I fear, has already become too long, which I shall have the honour to address to you, I shall endeavour to show that the new chemical doctrines, as they are commonly called, were the doctrines of Hook, who was contemporary with Sir Isaac Newton, and published prior to Mayow by him: and if in following up your plan I shall cast out any additional lights on so interesting a subject as you proposed, I shall feel highly gratified; and have the honour to remain, dear sir,

With all due respect and esteem,
Your faithful obedient servant,
ROBERT JOHN THORNTON.

XXXIX. *Memoir on the Wool and Sheep of Cachemire and Boutan. Read in the Agricultural Society of Paris in the Sitting of Frimaire 7, Year 9, by* ALEXANDER LE GOUX DE FLAIX, *formerly an Officer of Engineers, Member of the Asiatic Society at Calcutta, &c.**

AGRICULTURE, the most necessary and most useful of all arts, can flourish only under a good government. This principle has so often been proved, and is so evident, that it is sufficient merely to mention it. It is an axiom of political œconomy.

Among the different branches of rural œconomy, that of breeding sheep is, I will venture to say, one of the most advantageous: it requires constant attention on the part of the proprietors; it calls for the meditation of agriculturists and the solicitude of government. This branch, so interesting to commerce, the arts, and manufactures, began to be improved in France since Lormoy, in the year 1750, introduced Barbary sheep, and still more since the intro-

* From the *Decade Philosophique*, no. 16 and 17, year 12.

duction of the Spanish breed. This branch, so useful to the progress of all our cloth and woollen manufactures, is carried to such a degree of perfection in Cachemire, that the wool of that country, known there under the name of *touss*, is the finest and most silky in the universe. This fact I can prove by the shawls, the use of which began in France, and has thence been extended all over Europe since our expedition to Egypt. These superb articles, which ruin all our manufactures, since they cannot imitate them even with the wool of the Merinos, is fabricated in Cachemire with the *touss* of that country wool, which is so exceedingly beautiful that it might be taken for silk.

To publish processes, and the methods employed by the people among whom this art is cultivated with success, and to propose to government the putting them in practice, is placing confidence in its beneficent views. Sensible of this truth, I have endeavoured to make known in this memoir some processes used in Cachemire in regard to the manner of washing and taking care of the sheep, and the methods employed to prepare the wool. These methods, which have improved the sheep and ameliorated the wool, might be adopted and followed in France with advantage: they would be attended with beneficial results; at least, I have reason to think so, since the climate of these countries is nearly the same as that of France, as I shall prove hereafter.

No country in the world is diversified in a more agreeable manner than Cachemire; it unites the advantages of all climates. The plants which grow between the tropics thrive in the plains and on the sides of the hills of that small district, and those of the most northern regions become naturalized on its mountains, the summits of which are covered with snow throughout almost the whole year. In these points of view, Cachemire is one of the most agreeable countries of Indostan, since it is so much favoured by nature.

A pure and constantly serene sky, brilliant nights, continual dews, and innumerable springs which water the hills and the plains, the town of Sirinagar situated in the middle of fertile fields, the terraces of the houses of which form so many gardens suspended in the air like those of Semiramis, the celebrated queen of Babylon, as we learn from history, —all these give but an imperfect image of the country.

The mountains which surround this rich and fertile district produce abundance of aromatic plants, which afford excellent pasture for sheep: they are covered almost the whole year with wild thyme and sweet marjoram. It is to all these advantages united that Cachemire is in part indebted

debted for the superiority of its wool, and the beauty of its flocks. Care, and a few processes which we do not follow, and which I shall explain in this memoir, contribute to carry both to the utmost degree of perfection. France, happy by its situation, by the industry and the means of its inhabitants, and by the influence of its climate, might obtain all these advantages when it chooses: such a country must be extremely proper for breeding and improving all the species of sheep, and those brought from every part of the earth ought to thrive in it.

The Cachemirian sheep is one of the most beautiful of its species: its mean length is from thirty-six to forty inches; its height from twenty to twenty-two, and its weight from fifty-five to sixty pounds. The most distinguishing characters of this species are a small head and lively eyes; their front is not rough, and they have a long and wrinkled dewlap. The lambs are brought forth with crispy wool on the flanks, but they have only a few flocks on the back and along the spine. Each sheep produces, one with another, about three *sers* of thirty ounces each of clean wool; for it is never sold till it has once been washed on the animal before it is shorn, and then by processes which I shall here describe.

The body of these animals being well proportioned in all its parts, renders their gait light, easy, and secure. The care taken in breeding them, and the methods pursued, give them great vigour, a lively and even bold look, sound health, and a beautiful white covering of very long fine silky and undulating wool. They resemble those beautiful flocks which Virgil and his successful imitator Delille describe in their immortal poems; those flocks so celebrated in antiquity, the shepherds of which were kings. One of the valuable and essential qualities of the Cachemirian sheep is, that they stand heat as well as cold. Cachemire, being situated between the thirty-second and thirty-third degree of north latitude, and inclosed by a double chain of lofty mountains, experiences the heat of the torrid zone, and the cold of France: but the air of this country is constantly dry; and the successive transition, sometimes very sudden, from extreme heat to cold, is by no means prejudicial to the sheep. This effect, in my opinion, arises from the hardness of the cranium of these animals, their conformation, and the practice of not shutting them up. The same effect I have remarked in general in India, not only in the natives, who always go bare-headed, and who make continual use of ablution with cold water, but also in all the animals. The

sheep

sheep of Cachemire are not subject to giddiness and glanders, fatal diseases, which occasion so much havoc and destruction among sheep. I have made the same observation in regard to the sheep of the Arcadian pastures, and those in the pasturage of Etna and Parnassus; which being kept with great care, admit of being compared with those of Cachemire.

Whether owing to barbarism, or a mechanical attachment to the old habits of pasturage, which is the only occupation of the Tartars, since war cannot be one, the breeding of sheep is the branch of rural œconomy, most attended to in Turkey. The method of penning, and that of migration, have preserved there the fineness of the wool, and prevented deterioration of the animals. This is a certain truth, and which will be admitted by every traveller of observation.

In Cachemire, as in Greece and in Spain, the sheep are moved from place to place, that they may be kept all the year through in an equal temperature. They pass the winter in pens in the plains, and the summer on the mountains. They even enjoy this advantage in Cachemire, that the migrations are shorter and less laborious, because this small province is surrounded by high mountains.

But the Cachemirian shepherds, to secure their sheep from the effects of the great heat of the summer season, make them traverse a lake or a river several times a day. They never crowd them together in cots or confined places, as if nature had not given them a fleecy clothing capable of securing their bodies from the intemperance of the seasons. It is a fact well known that damp air is prejudicial to them; but it is proved also, that the acrid and almost mephitic air which prevails in close buildings, occasions among these animals putrid and inflammatory diseases, from which those of Cachemire are free. The humidity, say the natives of that country, which always prevails in obscure sheep-cots, however large they may be, is far more hurtful to these animals than the humidity of the atmosphere. Every one is able to appreciate the justness of this reasoning: the mephitism of cots would occasion to the strongest of these animals not only severe diseases, but would injure their wool.

Long experience has proved for centuries to the Cachemirian shepherds, what reason had demonstrated to the illustrious Daubenton, that the immediate action of the open air, daily bathing, and several times a day during the great heats, occasional showers, and the dews, as well as continual migration,

gration, instead of being hurtful, contribute to the health of the flocks, as well as to whiten and soften the wool. By these means also the wool acquires a silky texture, and at the same time it is whitened by the rays of the sun. Our shepherds, slaves to their prejudices, and deaf to the counsels of the wise Daubenton, are always apprehensive of extreme cold: what ought to render them easy in this respect is, that the flocks in Cachemire are inclosed in pens during the whole winter, and on mounts Athos and Olympus amidst frost and snow. I cannot help mentioning the latter instance; it is sufficient to convince even the most incredulous.

What I have said proves that the Cachemirians follow at all seasons that salutary method of penning, which allows the climate to have its full influence, so beneficial to the health of the flocks, and necessary to improve the fleeces, and maintain the beauty of the race.

But one particular care of the shepherds of this province, as well as of Thibet and Boutan, who possess the same breed of sheep, but which we do not observe, is to prefer a lamb of the second birth for a breeding ram. It has been proved to them by constant experience, that the rams of this birth are almost always stronger and more beautiful than those of the first, and even of any other. By following this practice they have been able to maintain and improve their breed. It is to this care, and that of not crossing the breed, a practice followed by the Arabs, who never mix the breeds of their beautiful horses which they call the noble breeds, that they are indebted for the extraordinary fine white silky wool, which generally, from the nape of the neck to the flanks, is from twenty to twenty-two inches in length: but it may readily be conceived that the wools on the flanks and lower parts of the body cannot be equally long. Every where the wool, however, of these animals is at least five or six inches, and equal in length. This wool, in fineness and whiteness, exceeds that of the Merines, and that even of the sheep of the Algerine states, and of Angouri, a town in Turkey in Asia, which we call Angola. This assertion is proved by what I have already observed in regard to shawls.

Salt, the use of which has for some time past been introduced among us, mixed with a root called commonly in Europe Indian saffron, and which in botany is denoted by the name of *curcuma*, *terra merita*, given at different periods, more or less distant, according to the season, the quality of the pastures, and that of the herbs they produce,—less frequently

quently in winter and during very cold weather, but oftener in the time of the great heats, and when the air is damp,—is the only remedy employed by the Cachemirian shepherds to prevent diseases among their flocks. A milky plant, called in Indostan *ardepal*, of an exceedingly bitter taste, is used by them also with great success: they make the sheep eat of it when they observe any of them in a languishing state.

This plant, so useful, would succeed, in my opinion, in our climates: it thrives without care on the mountains as well as in the plains; in dry soils as well as in moist. Its utility renders it exceedingly valuable: we ought to endeavour to naturalise it, because it is salutary not only to sheep but to all other animals. It is given in particular to sheep and to goats, as a specific against the itch; the clavelée, swellings and contagious diseases which sheep contract during very damp weather, when the herbs shoot up, and the fresh pastures contain small insects, which occasion among these animals the rot; in the latter case they are made to eat it; for the itch they are rubbed with the juice.

The stem of the *ardepal* rises to the height of from fifteen to eighteen inches; it is woody, and of the size of the little finger: its bark is very smooth, reddish, and velvety: the leaves stand opposite to each other, are sixteen or eighteen lines in length, shaped like a heart, velvety, nervous, tender and thick. They always abound with a milky juice, which is exceedingly bitter; they are faintly indented, about as large as a piece of thirty sous, and of a dark green colour. The roots are ramose, yellowish, tender, and contain a juice similar to that of the leaves, but thinner. The flower is divided into five petals, of the length of two or three lines, and a line in breadth; they are rounded at the extremity, of a jonquil colour, inclosed in a monophyllous calyx, which remains and envelops the pod or oblong fruit, which succeeds the flower: the flower has three stamina, and an acute ovarium unprovided with a style. The fruit is divided into three cells, separated by a strong membrane, each containing three or five spherical seeds: each of these seeds is inclosed in a hard capsule, of a reddish brown colour, the kernel of which is very bitter, yellowish, and rather soft.

In general Cachemire is very proper for the breeding of sheep; but I must observe, that the shepherds never give them green herbs, but thyme and marjoram. In pens they get nothing to eat but dry straw mixed with a small quantity of barley or millet, named *jouari*; and during their migrations, or in the fields, they are allowed to feed only on dry herbs, or the leaves of the bushes.

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What I have here said is contrary to our ideas and methods in regard to the breeding of sheep. Meadows are no where found in Indostan. The Hindoo is convinced that an ear of rice or wheat, or of any other gramineous plant, is preferable to ten and even to a hundred trusses of hay.

The fleeces of the Cachemirian sheep are in general in good condition, because the flocks are never conducted among brush-wood, which would tear the wool on the back of the animal. It is well known that the only wool susceptible of acquiring delicate and brilliant colours by the process of dyeing, is white wool: for this reason the Cachemirians separate all those lambs which are black or brinded. It is known also that the longest is the fittest for being spun, and for making strong cloth.

The general practice in Cachemire is to shear the sheep only once in the year. By this method the wool obtained is longer and of a better quality. But the shepherds of this country know, that if the fleece were left on the animal for a long time, and particularly on ewes, they could neither suckle their young nor be rendered productive. I shall not enter into any explanation of these motives, as the utility of both practices has been proved by experience: I shall therefore only observe, that the shearing takes place fifteen or twenty days after the return of the great heats, in order that the sheep may perspire; which renders the wool more pliant.

An essential and peculiar quality of the Cachemirian wool is, that it has no hard coarse part. This is a valuable quality, since hard wool is found even among that of the Spanish sheep.

At the time of shearing, the Cachemirian shepherds, who have long studied every thing that can contribute to preserve the beauty of their breeds, to improve the wool, and prevent diseases among their flocks, bathe the sheep twice a day, and even oftener when the heat increases and renders it necessary. The periods for performing this operation are two hours after sun-rise, and the afternoon, when the rays of the sun begin to be weakened in consequence of their obliquity. They have observed that bathing when the sun is vertical crisps the wool, renders it harder, checks perspiration, and exposes the sheep to the danger of what is called strokes of the sun: this is a severe accident, and occasions fevers which are called giddiness.

Cleanliness is the first cause of health: this principle is true in every respect; it not only preserves from diseases, but maintains the beauty of form. Every European travel-

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ler, who has been in the habit of observing, knows that the Hindus are indebted for the beauty of their hair, which is exceedingly long, to the frequent use of bathing and ablutions; and they are also less subject to colds than the Europeans, who never bathe their heads.

The Cachemirian wool is divided into two kinds: that of the young sheep, which is called *arouel*; and that of the old, distinguished by the name of *duaume*. The fleeces of the lambs, till the age of two years, or eighteen months, are sold separately; they are employed only for making a kind of fur to winter caps.

The first of these kinds is a little shorter than the other; it is produced by sheep from the age of three years, when the shearing of the *touss* begins, to that of seven or eight.

The *duaume* is longer, a little less greasy, weaker, and less silky; it is employed for making the Cachemirian cloths, which have been imitated by the English. We also have attempted to make them in our manufactories; and they are known in Europe by the improper name of *Casimir*, whereas the real name ought to be *Cachemir*.

I have already remarked, that the wool, before it is shorn, is washed on the animals. These two kinds of wool are each sub-divided into two sorts, that of the back and that of the belly: but before they are employed in commerce, or spun, they are subjected to certain operations, by which they are improved. These operations, so useful and beneficial, are not practised in Europe. They are first exposed to the vapour of a slight ley, composed of nearly fifty pints of water, about ten or twelve pounds of the ashes of the leaves of the banana tree, or of a clayey barren and white earth, which is easily reduced to powder, and which by the Indians is called *ole*. They are then washed with the farina of a small cylindric bean, called *moungue*, known in botany by the name of *mango*. The shawls in India are washed with the same farina.

The first of these processes consists in exposing the wool for seven or eight hours to the vapour of the ley, that it may be penetrated by it. The wool is heaped up, without being pressed down, upon an earthen ware dish; it is washed in running water, and dried in the open air.

When this operation is terminated, the wool is subjected to another: it is left to soak in an earthen vessel, and each flock is rubbed several times in the same manner as linen is by our washerwomen. It is then repeatedly rinsed in pure water, or in a river, to free it from the farina with which it has been washed. These processes render the wool more

 pliable

pliable and silky, and bleach it without breaking or tearing it: and the farina of the *moungue* has the property also, by its mucilage, of softening it, and giving it a peculiar whiteness without crisping it; which any other substance would do.

It has been asserted, on the authority of some travellers, that shawls are made from the hair of a kind of goat: in my opinion it might be said, with equal propriety, that they are made of the hair of the stag. I am astonished that writers should amuse themselves at the expense of the public by spreading such falsehoods.

Another idea, no less distant from truth, is, that these shawls are made from the wool of lambs torn from the bellies of their mother. This account, which cannot be read without sentiments of pain, is not only absurd but atrocious; it is contrary to every thing we know of the mild and humane manners of the Hindus. Besides, this assertion cannot be true, as it is well known that the wool of those lambs is very short; and such a practice would be destructive to the sheep, in consequence of the danger attending the operation.

The superfine shawls are not made of sheep's wool, but of the wool of the camel. This wool, with which we are not acquainted, and which cannot be cultivated in France without considerable expense and great difficulty, is exceedingly valuable; it is more beautiful than Vigonia wool, and as dear as it is scarce: it is found only on the forehead and around the ears of that large animal.

The finest shawls, those made of camels' wool, besides being exceedingly dear*, are very scarce, and it is difficult to procure them; it is even often necessary to order them at Sirinagar, the capital of Cachemire, the only place where they are manufactured.

The common fine shawls manufactured in Cachemire are the white, and cost two or three pounds sterling: they have flowered corners, and a border of greater or less breadth according to the price. They are three ells and a half in length, and half an ell in breadth. The common ones only are dyed, unless ordered to be so. The latter cost from twenty-five to thirty shillings.

Shawls, the weft of which is camels' wool, are distinguished by the name of *cacacheti*; the white, with the weft of sheep's wool, are called *seaumi*; and the rest are known by the appellation of *passari*. I have thought it necessary

* They cost ten guineas at the manufactory.

to

to distinguish them here by the names given to them in the country. This nomenclature, if a matter of indifference to the consumer, will not be so to commerce.

As this wool is not sold till it has been scoured, washed, and subjected to the process of washing with the farina of the *moungue*, it gives no more loss: some of the shepherds have assured me that the loss ought not to be estimated at more than a fourth of the weight; a new advantage resulting from this kind of sheep.

The wool of the belly is never employed for shawls; it is used for a particular kind of stuff manufactured in the environs of Sirinagar. This stuff is consumed in the country and neighbouring provinces. The wool is sold at from fifteen to twenty-five shillings per *ser*, which weighs twenty ounces French weight. The whole is sold in the country, to be manufactured into shawls, sashes, or borders for turbans; the two latter are only half an ell in breadth.

The Cachemirian pieces of cloth are more than sixty French ells in length, and a little more than half an ell in breadth. The price at the manufactories amounts only to the moderate sum of fifteen pence. These cloths, far superior either to those of England or France, are worth only a fourth of what they are sold at in the latter countries. Besides great disproportion in the price, there is also a great difference in the quality of the casimirs: those of Cachemire last much longer. This superiority can be ascribed only to the superiority of the wool.

To propose to the French government to send for this breed, either to rear them in France, or to improve the best of our breeds by crossing them with rams and sheep of the Cachemirian breed, is to propose a project worthy of it. We already experience the advantages resulting from the breeds obtained in Spain: the wool produced by crossing the Merinos by our indigenous breeds has been much improved, and great advantage might certainly be expected from crossing with the finest sheep in the world. This new attempt would bring our wool to a state of perfection. I have even reason to think, from the observations and experiments of Daubenton, to be found in his work entitled *Instruction pour les Bergers*, that the wool of France might be improved to such a degree that it would become superior to that of Cachemire. "Experience has proved to me," says he, "that it would be easy to preserve and improve in France the breeds of fine-woolled sheep, and that the rearing of these sheep would be of great advantage to our farmers, and a great resource to our manufactories." There can be no

doubt that, by crossing the Cachemirian breed of sheep with our own sheep or the Merinos, it would be possible to obtain in France superfine wool as beautiful as that employed in manufacturing the magnificent shawls, the fineness, silky texture, and whiteness of which we so much admire. I may even assert without prejudging too much, that this wool would become superior to that of Cachemire; it would carry our cloths, known to be the most beautiful in the world, to the highest degree of perfection.

It perhaps will be objected, that admitting the possibility of introducing and naturalising in France this breed of fine-woolled sheep, the most beautiful on the earth, there would be some disadvantage in regard to the weight of the fleece; since it is well known that Merinos, brought from Spain and bred in France, commonly produce twelve pounds of wool, while the Cachemirian breed produce only seven or eight. But the difference in the fineness might perhaps make up for this deficiency; because the same quantity of stuff can be made with a fourth or a third less of Vigonia wool, than with the finest Spanish wool, in consequence of the superior fineness of the former. It would be a matter of indifference, therefore, to have a few pounds less of produce, provided the same quantity of cloth were obtained. Besides, the Cachemirian wool being much finer, and absolutely free from any coarse part, a great benefit would arise from rearing this breed, which require less nourishment, and are fed with straw; which is never the case with the French sheep or the Merinos.

The loss which the merchants sustain by purchasing unscoured wool, would not exist were the Cachemirian sheep naturalised in France. As Daubenton was probably mistaken, when he said, in his *Instruction aux Bergers*, that government sent for Cachemirian sheep at the same time that it procured sheep from Roussillon, Spain, and England, I am the more inclined to believe that my conjecture respecting this error is well founded; because, having had an opportunity, during my residence in India from 1769, to 1788 when I returned to Europe, of seeing the correspondence of the old East India company, whose privilege ceased in 1770, and, since that period, the correspondence of the royal administration, I found nothing which had any relation to this circumstance.

To bring sheep from Cachemire is certainly not impossible; but though such an attempt does not present the same risk as the expedition of Jason, it would, however, be very difficult, especially to one unacquainted with the Indian languages,

guages, and not familiarised with the manners of the Indians. I must therefore repeat, that Daubenton, and those who, without further examination, have repeated his assertion, that in the year 1776 Cachemirian sheep were sent for to be introduced into France, were evidently mistaken.

To Mr. Tilloch.—(*Letter* II.)

XL. *Curious Extracts from old English Books, with Remarks which prove, that the Telescope, &c. were known in England much earlier than in any other Country.*

1. At the conclusion of my last letter*, I intimated that I had found a passage in an old book, which threatens to deprive lord Napier of the honour of being the first among the moderns who re-invented the method by which Archimedes made the solar beams destructive to the Roman fleet; and which also justifies a belief, that the revival of the telescope, generally acknowledged to have been known to, if not invented by, Roger Bacon, took place earlier than is commonly supposed.

2. The passage I allude to is to be found in the *Pantometria* of Leonard Digges, esq. first printed at London in 1571†, and again by his son Thomas Digges, esq. in 1591. In the preface to this second edition, written by the latter, we read what follows:

"3. Archimedes also (as some suppose) with a glasse framed by reuolution of a section parabolicall, fired the Roman nauie in the sea, comming to the siege of Syracusa. But to leave these celestiall causes, and things doone of antiquitie long agoe, my father, by his continuall painfull practises, assisted with demonstrations mathematicall, was able, and sundrie times hath, by proportionall glasses, duely situate in conuenient angles, not onely discouered things farre off, read letters, numbered peeces of money with the verye coyne and superscription thereof, cast by some of his freends of purpose, upon downes in open fields, but also seuen

* It will not be amiss if, before the reader enter on this second letter, he peruse the first, on the "Memoir by lord Napier," &c. inserted in no. lxix of this Magazine.

† See Robins's Mathematical Tracts, vol. ii. p. 252, compared with the art. *Telescope* in Dr. Hutton's Dictionary, and with the title page of the *Pantometria*.

 myles

myles off declared what hath beene doone at that instant in priuate places. Hee hath also sundrie times, by the sunne beames, fired powder and dischargde ordinance halfe a mile and more distante; which things I am the boulder to report, for that there are yet liuing diuerse, of these his doings *oculati testes**, and many other matters farre more strange and rare, which I omit as impertinent to this place."

4. On looking farther into this interesting old treatise, I find, in the 21st chapter of "the fyrst booke," the following curious paragraph:

"Thus much I thought good to open concerning the effects of a plaine glasse†, very pleasant to practise, yea most exactly seruing for the description of a plaine champion country. But marueillous are the conclusions that may be performed by glasses concaue and conuex of circulaire and parabolicall formes, using for multiplication of beames sometime the aide of glasses transparent, which by fraction should unite or dissipate the images or figures presented by the reflection of other. By these kinde of glasses or rather frames of them, placed in due angles, yee may not onely set out the proportion of an whole region, yea represent before your eye the liuely image of euery towne, uillage, &c. and that in as little or great space or place as ye will prescribe, but also augment and dilate any parcell thereof, so that whereas at the first appearance, an whole towne shall present itselfe so small and compact together that yee shall not discerne anye difference of streates, yee may by application of glasses in due proportion, cause any peculiare house or roume thereof dilate and shew itself in as ample forme as the whole towne first appeared, so that yee shall discerne any trifle, or reade any letter lying there open, especially if the sunne beames may come unto it, as plainely as if you were corporally present, although it be distante from you as farre as eye can discrie: But of these conclusions I minde not here more to intreate, hauing at large in a uolume by itself opened the miraculous effects of perspectiue-glasses‡. And that not onely in matters of discouerie, but also by the sunne

* Eye-witnesses.

† By glasses the author here means any plane reflecting surfaces; for he begins this 21st chapter of his first book with these words—"The best kinde of *glasse* for this purpose is of *steele* finely polished, neither conuex nor concaue but flat, &c."

‡ Most probably this work is lost among the "several mathematical treatises ready for the press, which, by reason of law-suits and other avocations, he was hindered from publishing." See Dr. Hutton's Dictionary, article *Digges*.

beames

beames to fire powder, or any other combustible mater, which Archimedes is recorded to have doone at Syracusa in Sicilie, when the Roman nauie approached that towne. Some haue fondly surmised he did it with a portion of a section parabolicall artificiallye made to reflect and unite the sunne beames a great distance off, and for the construction of this glasse, take great peines with high curiositie to write large and many intricate demonstrations, but it is a meere fantasie and utterly impossible, with any one glasse whatsoeuer it be to fire any thing, onely one thousand pace off, no though it were a 100 foote ouer, marry true it is, the parabola for his small distance, most perfectly doth unite beames, and most uehemently burneth of all other reflecting glasses. But how by application of mo glasses to extend this unitie or concourse of beames in his full force, yea to augment and multiplie the same, that the farder it is caried the more violently it shall pearse and burne. *Hoc opus hic labor est*, wherein God sparing life and the time with opportunitie seruing, I minde to imparte with my countriemen some such secrets, as hath I suppose in this our age beene reuealed to very few, no lesse seruing for the securitie and defence of our naturall countrey than surely to be maruailed at of strangers."

5. No writer on optics whom I have had an opportunity of consulting, gives us any thing satisfactory on these curious passages. In one of our latest and best scientific dictionaries, a part of our first quotation (§ 3.) is given without any comment, and the able writer of the article *Telescope* in another late excellent General Dictionary, contents himself with mentioning the name of Digges in respectful terms. Dr. S. does not mention the Diggeses at all; and Mr. R. in his remarks on that learned gentleman's system of optics, does little more than cite a small part of our second quotation (§ 4). I have not looked into any foreign authors on this occasion; thinking it very unlikely that I should find in them any satisfactory account of two old English books, which have been so sparingly noticed by our own writers. Modesty as well as prudence, recommends caution in a case where men of deserved celebrity have been so very circumspect. Yet I shall offer a few remarks with that freedom which becomes the cause of truth, trusting to your intelligent readers for a candid construction of what I shall advance.

6. And first I would ask, with all possible respect, whether (to say nothing of theory) the able men I have alluded to, might not be *partly* discouraged from hazarding any remarks

on the passages before us, by contemplating the very great distance at which Digges asserts that his father fired gunpowder by means of the solar rays? a distance which exceeds that which, in our former letter, we ventured, perhaps hastily, to think rather *poetical*, in a greater ratio than that of 2640 (the feet in half a mile) to 2002, or than that of 13 to 10. The gentlemen could not be ignorant that Archimedes was said to have produced his famous conflagration at a great distance; and this, after all, may have been the true state of the fact. But it is probable that neither of them had seen Napier's proposal to excite flame "at *any* appointed distance." Surely an expression which, as observed in my last, needs qualification, cannot be adduced in support of another which almost exceeds belief. But, to avoid all controversy in a case which admits of some latitude of opinion, I would respectfully *ask* better judges of the subject, Whether the light * of the sun, reflected from terrestrial objects, be not always accompanied with a real, though often insensible heat, which *cæteris paribus*, is ever proportional to the density of such light? Whether windows partially reflecting the rays of the sun when near the horizon, may not be seen at a great distance; and whether the spectator does not receive from them a real, though generally an immeasurably small, portion of heat? Whether the sun-beams, partially reflected from the smooth surface of the sea, do not sensibly increase the heat on shore; and whether this effect be not universally experienced,

* So much convinced was the celebrated Gravesande of the intimate connection between fire and light, that he defines a lucid body in these words—"*Corpus vocatur lucidum, quod lumen emittit, id est, ignem per lineas rectas agitat.* A body is called lucid which emits *light*, that is, gives *fire* a motion in right lines." *Phys. Elem. mathem. Exper. confirm.* printed 1721, vol. ii. p. 11. See also the able Dr. Hutton's Dictionary, article *Light*. For the benefit of those who are always hunting after new books, which are very often *old* books improved for the *worse*, it may not be amiss to add that, about seventeen years ago, I heard professor John Robison, of Edinburgh, certainly one of the best judges in Europe, recommend this work of Gravesande (the third edition, if I rightly remember) as, upon the whole, the best book of the kind that had then been published; and I do not know that any work of equal merit and extent has since appeared. Whether the professor said any thing in praise of the English translation I do not recollect, but I rather think not. The truth is, that the excellent preliminary discourse, the only part of the English edition I have read, is but indifferently translated. A work on natural philosophy has long been expected from Mr. Robison himself; but science has not hitherto received this benefit, owing, I believe, to his poor state of health. We may judge of the manner in which it would have been executed by the articles he has given to the Encyclopædia Britannica.

enced, or at least regarded as real, by the inhabitants of hot countries, even at considerable distances from the water? Whether if such heat, instead of being indefinitely diffused, could be united in one spot, a very great effect might not be expected at a very great distance? Whether Buffon has ascertained the limit, the *ne plus ultra*, at which combustion can be produced by the reflected solar rays; and whether, on the contrary, he does not confidently affirm, that, with a better apparatus, he could have produced the same effect at a proportionably greater distance, as from the nature of the case itself he evidently could? Whether, if Maupertuis's idea of an amphitheatre lined with mirrors were realized; or if, as you once suggested, a body of 2000 or 3000 men, each furnished with a speculum, were trained to direct the sun's image to a particular spot, bodies might not be inflamed at distances of which at present we have no conception? As the Diggeses, both father and son, appear to have enjoyed, at one part at least of their lives, the invaluable privilege of making any costly experiments they thought proper at the public expense*, whether they may not have possessed an apparatus as much larger than Buffon's, as the effect was greater?

7. Whatever answers your intelligent readers may think due to these queries, not a man of them will doubt that Digges, the father, actually fired gun-powder, *at some great distance*, by means of the reflected rays of the sun; and if so, lord Napier's first proposal must have been anticipated by many years.

8. I thought the two foregoing passages from the *Pantometria*, especially the second, sufficiently wonderful; but, when I had written thus far, a learned and worthy friend of yours and mine put into my hand the *Stratioticos* of Thomas Digges†, printed in London in 1590; at the 359th page of which I find the following astonishing, but, as I hope to prove, not unaccountable passage:

9. My father, "joyning continual experience" (in the use of artillery) "for many yeares with geometricall demonstrations, sought, and at last found, and did frame an instrument, with certaine scales of randons, to perfourme all that Tartalea by his tables promised: as also by reflection of glasses to fire pouder and discharge ordinance many

* See *Pantometria*, p. 175.

† In a list of Thomas Digges's works, at the beginning of the Stratioticos, we find that he was the sole author of that piece, and that the *Pantometria* (second edition) was begun by his father, and augmented and finished by himself.

miles

miles distant. And such was his felicitie and happie successe, not only in these conclusions, but also in y^e Optikes and Catoptikes, that he was able by perspective glasses duely scituate upon conuenient angles, in such sort to discouer euery particularitie of the country round about, wheresoeuer the sunne beames might pearse: as sithence Archimedes (Bakon of Oxford onely excepted) I have not read of any in *action** euer able by means natural to performe the like. Which partly grew by the aid he had by one old written book of the same Bakon's experiments, that by strange adventure, or rather destinie, came to his hands, though chiefly by conioyning continuall laborious practise with his mathematicall studies. The which upon this occasion I thought not amisse to rehearse, as wel for the knowne veritie of the matter (diuers being yet aliue that can of their owne sight and knowledge beare faithful witnesse, these conclusions being for pleasure commonly by him with his friends practised) as also to animate such mathematicians as enjoy that quiet and rest my froward constellations haue hitherto denyed me, to imploy their studies and trauels for inuention of these rare seruiceable secrets. But such is my hard destinie, that as God's pleasure was to take my father from me, in my young and tender yeares, and even at that verie time when I began to grow capable of those secretes, and himselfe (hauing bene long debarred his owne inheritance and natiue soile being restored) ment then immediately to returne to his wonted places of exercise, there to have deliuered me experimentally those the fruits of his long trauels and practises, so sithence his death, having fostered by study and conference those theorical sparks mathematicall, from infancie by him impressed, after I grew to some maturitie of yeares and judgement, fit to enter into trial and practise of these conclusions, by continuall law-brables (being torments as repugnant to my nature as the infernall Furies to celestiall Muses) I haue for many yeares bene so vexed and turmoiled, and from those delectable studies violently haled, that of all those rare conclusions and secrets I haue scarsely hitherto had any time of repose or quiet to wade effectually in any one, saue onely that of great artilerie," &c.—But "so soone as by God's aid I shall untwine my selfe out of this miserable labyrinth, wherein so long I haue bene snared, my first endeuours shal be entirely to finish the treatise of that new science of maneging this new furious engine and rare inuention of

* The original being in the old English black letter, the word *action*, like the other emphatic words, is in the Roman character. Does the author mean *actually*, or *in battle?*

great

great artillerie, in such perfection as hitherto hath not bene in any language imparted with any nation of Europe.—*Virescit vulnere virtus**."

10. I have transcribed the greater part of this curious passage, because the "miserable labyrinth" of "law-brables" in which the poor author was "snared," may very rationally account for the amazing assertion, that his father, "by reflection of glasses, fired pouder and discharged ordinance many miles distant." It is evident that when Digges wrote the above passage his mind was ill at ease. It is probable his work was carelessly printed, without being revised by himself, and that for *miles* we should read *poles*, or some other denomination inferior to miles; for it is not to be credited that Digges, supposing him in his senses, would have inserted in his *Stratioticos* in 1590, that his father, "*by reflection of glasses, fired pouder and discharged ordinance many miles distant*;" and in the *Pantometria* in 1591, that his father produced the same effect only "*halfe a mile and more distant*;" appealing in both instances to eye-witnesses, and to all appearance meaning precisely the same fact. It may further be observed, that in our second quotation he has not asserted that either he or his father had so "augmented and multiplied the unitie of beames, that the farder it is carried the more violently it shall pearse and burne." No: he only mentions the extreme difficulty of such an attempt, and rather obscurely talks of imparting something on that head on a future occasion.

11. This letter would exceed all reasonable bounds, and would consume more time than I can bestow upon it, were I to trouble you with every observation which these passages would fairly bear. Many such will so readily occur to your intelligent readers, that it would be superfluous, if not officious, in me to suggest them. I must therefore content myself with settling the dates of other pretensions to discoveries which seem to have been previously known to the Diggeses, and thus hastening, not however without all the circumspection my time will allow, to the general conclusion which I have in view. And here I should be sorry to have it supposed that the proofs I shall adduce in support of those who appear to have just claims of priority, imply any censure on other claimants. Far from every liberal inquirer be the baseness of vilifying departed men of talents, whom genius, or even what is called good fortune, may have conducted, clear of all plagiarism, to discoveries previously made by others!

* Virtue flourishes in adversity.

12. To

12. To proceed then: Our second quotation (§ 4.) seems clearly to imply the knowledge and use of what we call the *Camera obscura*, which has been always believed to have been first described by John Baptista Porta *. Whether this our second quotation was written by Digges the father or son, we have no absolutely certain means of determining; for the *Pantometria*, from whence it is taken, was begun by the father, as we have seen, and "augmented and finished" by the son, who, it is *possible*, might have interpolated this passage into that part of the work, which most probably was written by the father, as it stands in the 28th page of the book, which, exclusive of preface, &c., contains 195 small folio pages. But is it reasonable to suppose that a man who, as our first quotation shows, was acquainted with the more difficult combinations of glasses, and "assisted with demonstrations mathematicall," was ignorant of the comparatively simple structure of the *Camera obscura?* If then Digges the father, who published the *Pantometria* in 1571, and died about the year 1574 †, really knew, as in all probability he did, the structure and use of that instrument, he must have preceded Porta in that knowledge by more than twenty years. But if Digges the father did not possess that knowledge, it seems undeniable that his son did; and 1591, the date of the *Pantometria*, will still carry an Englishman's pretension about three years beyond that of the respectable Italian, whose work did not appear till about 1594.

13. I shall next briefly discuss a more important claim, that of the invention or revival (shall I call it?) of the Telescope. Descartes, whose authority in this case, as in many others, is justly regarded, tells us, that "about thirty years ago ‡ lived one James Metius, a native of Alcmaer in Holland, a man wholly ignorant of the liberal arts, though his father and brother || cultivated the mathematics. This

* In his *Magia Naturalis*, lib. xvii. cap. 6. according to Dr. Hutton's Dict. art. *Camera Obscura*; and in lib. iv. cap. 2. according to Wolfe, and Stone, who copies much from him. They agree that that work of Baptista Porta was first printed about the year 1594. See *Elem. Math. Univ. Optic.* § 80, and *Diopt.* § 227; and Mathem. Dict. articles *Camera Obscura* and *Telescope*.

† Hutton's Dict. art. *Digges*.

‡ That is, about the year 1607, or thirty years before 1637, when he first published his *Dioptrice*. See Hutton's Dict. art. *Cartes*. The above extract, which on several accounts is worthy of transcribing, is taken from Elzevir's edition of that work, 1644. cap. i. § 1. p. 71.

|| Descartes here means Adrian Metius, professor of the mathematics at Franckenaer, who supported his brother's claim to the discovery.

man's favourite amusement was to make burning glasses and specula; and in winter he formed some even of ice, a material which is known by experience to be not unfit for this purpose. As on account of this pursuit he had at hand many glasses of various forms, by a lucky hit he applied two of them to his eye, one of which was somewhat thicker at the middle than at the edges; the other, on the contrary, being much more prominent at the edges than in the middle; and thus having happily fitted them to the extremities of a tube, the telescope of which we speak thence derived its existence." Saverien, not attending, as he ought, to these words of his illustrious countryman, who passed much of his time in Holland, tells us that "Kepler is the inventor of the telescope," and that "it certainly was not brought into use till the year 1609 *." But Kepler himself advances no pretensions to the discovery. In the dedication to his *Dioptrice*, which is dated January 1611, he says that "some were then contending about the honour of the first invention of the instrument, and others boasting of having brought it to perfection; but that Galileo had secured a more splendid triumph, in having first shown its use in detecting the *arcana* of astronomy,—a triumph, by the way, to which, with all due respect to the celebrated "Tuscan artist," our great countryman Harriot has equally strong pretensions †. Kepler then modestly prefers his claim to the first discovery of the *rationale* of "the dioptrical reed" (*arundo dioptrica*), as he calls the telescope, but by no means to the discovery of the instrument itself. Borelli ‡ and other writers favour the pretensions of Jansen of Middleburgh, and Sirturus those of Lippersheim, another Dutchman.

14. But the earliest claim, next to that of the Diggeses, and the still prior one I shall presently notice, is that of John Baptista Porta, whose pretensions to the first discovery of the *Camera obscura* we have just considered. This modern Italian Mæcenas, in his *Magia Naturalis*, published, as we have seen, about 1594, has these words, "*Si utrumque recte*, &c. If you know how rightly to combine both these" (a concave glass and a convex one) "you will clearly

* Saverien, *Diction. Univ. de Math. et de Physique*, articles *Lunette* and *Telescope*.

† See the account which Dr. Zach, astronomer to the duke of Saxe-Gotha, published in the Astron. Ephem. of the Royal Acad. of Sciences at Berlin for 1788, of Harriot's papers found by him in 1784 at Petworth in Sussex, the seat of lord Egremont. See also Dr. Hutton's Dict., or the Encycl. Britan. art. *Harriot*.

‡ In his tract *De vero Telescopiorum Inventore*, ed. 1655, cap. 12.

see

see both remote and near objects enlarged. In this respect I have given no small assistance to many of my friends," &c. From this passage, Wolfius concludes that "*Primus dubio procul*, &c. Beyond all doubt Porta was the first who constructed a telescope." But Wolfius adds that "he did not understand his own invention, for which he acknowledges he was indebted to chance," &c.* It is however highly probable that the candid Wolfius, for such, from many instances, he appears to be, and the honest, ingenious, Scottish gardener, Stone, who here translates his words, would not have spoken so very positively in favour of Porta's pretensions, had they been apprised that Digges, the father, not only constructed, but understood the telescope in the year 1571, when the *Pantometria* was first printed.

15. But the knowledge of the telescope in this country, at least of its theory, may be distinctly traced to a still earlier date. In proof of this assertion, which to some will appear a bold one, I beg leave to refer you and your readers to Recorde's "Path-way to Knowledge," a book on the elements of geometry, printed in the year 1551, and dedicated to king Edward VI. of England. Though this book is, I believe, not remarkably scarce, I may venture to say that its contents are but little known. For, after all the disputes about the discovery of the Telescope, can it be supposed that the following paragraph would have been so long withheld from public view, if the book itself had not lain neglected, in the repositories of the curious, ever since the days of Jansen, Kepler, and Galileo? In the repositories of the curious! Shall I speak out a melancholy fact?—For little more than the price of waste paper I delivered my venerable Recorde, once the companion and instructor of an amiable prince †, from the merciless hands of a snuff-man, who, regardless of his gemowes, likeammes, nooks, and cantells ‡, had stripped off his outer garments, and, *proh pudor!* condemned him to the meanest purposes of a vulgar trade, thus forcing snuff into the indignant embrace of geometry!

16. Recorde, in his preface, has this remarkable passage: "But to retourne againe to Archimedes, he did also by art perspectiue (whiche is a part of geometrie) deuise suche glasses within the towne of Syracusa that did burne their enemies shippes a greate waie from the towne, whiche was a meruailous, politike thynge. And if I should repeate the

* See *Wolfii Elementa Mathescos Universæ, Diopt.* § 327; and Stone's Mathemat. Dict. art. *Telescope.*

† Edward VI.

‡ Parallels, parallelograms, sectors, and segments.

varietie of such straunge inuentions, as Archimedes and others haue wrought by geometrie, I should not onely excede the order of a preface, but I should also speake of suche things as can not well bee understoode in talke without some knowledge in the principles of geometrie. But this will I promise, that if I maie perceiue my paines to be thankfully taken, I will not onely write of suche pleasaunte inuentions, declaryng what they were, but also will teach how a great nomber of them were wroughte, that they maie be practised in this tyme also. Whereby shall be plainly perceiued that many thynges seeme impossible to bee done, which by arte maie verie well bee wrought. And when they bee wrought, and the reason thereof not understoode, then saie the vulgare people, that those thynges are doun by negromancie. And hereof came it that frier Bacon was accompted so greate a negromancier, whiche neuer used that art (by any coniecture that I can finde), but was in geometrie and other mathematicall sciences so experte that he could doe by them suche thynges as appear wonderfull in the sight of moste people. Great talke there is of a glasse that he made in Oxforde, in whiche men might see thinges that weare doen in other places, and that was iudged to bee doen by power of euill spirites. *But I knowe the reason of it to bee good and naturall, and to be wrought by geometrie (sith perspective is a parte of it), and to stande as well with reason, as to see your face in a common glasse.* But this conclusion, and other diuers of like sort, are more meete for princes, for sundry causes, then for other men, and ought not to be taught commonly."

17. On this passage I shall only observe, at present, that we have no right to doubt that Recorde actually "knew the reason" of the reputed magic of Roger Bacon's glasses, of which there was "great talke" in his time. For, besides his reputation as a physician, he had a mathematical character at stake; having for some time publicly lectured on geometry at Oxford*. Nor can it be said that Recorde might affect a knowledge of optical glasses which he did not possess, and cloak his ignorance under the strange opinion (as it appears to us) that such knowledge was only "meete for princes." For he dedicates his book to Edward VI. in a long address, dated 28th January 1551; and is said to have been physician to that excellent young prince, as well as to his miserably bigoted and tyrannical successor Mary †, either of whom might have required him to com-

* See Dr. Hutton's Dict. art. *Recorde.* † Id. Ibid.

municate

municate the knowledge he pretended to have of Bacon's inventions. A man ignorant of what he professed would never have unnecessarily exposed himself to the danger of being held up by the rival court physicians as an empiric in "perspective" (optics), and *consequently*, as they would not have failed to infer, in medicine. Thus we have great reason to believe that Dr. Recorde possessed considerable knowledge, at least of the *theory*, of that combination of optical glasses now called a refracting or dioptrical telescope.

[To be continued.]

XLI. *Letter of* SPALLANZANI *to* C. SENEBIER *in regard to Respiration**.

YOU know that for a long time the respiration of man and of animals has been the principal object of my physical researches. I made you acquainted with the motives which induced me to treat on this subject, and the plan which I formed of subjecting to examination the different classes of animals, beginning with those where animality ends, and ascending by degrees to that which comprehends the mammalia. Before my labour, which is pretty far advanced, be completed, I am desirous of communicating to you some parts of it; but this is not so much to gratify your wishes as to know your opinion of it. I shall, therefore, take the opportunity of this letter to communicate to you in particular a phænomenon, the enunciation of which will, perhaps, excite in you some surprise.

As I intend to treat on respiration, it is evident that I ought to introduce living animals which breathe. I shall, however, pursue a contrary course, and shall first give my observations on dead animals, or animals which have been deprived of respiration.

Animals which breathe have, indeed, been the first object of my researches; but in proportion as I observed the chemical changes produced by them in air during their life, I endeavoured also to discover those produced after their death.

No means certainly can be more efficacious for advancing the progress of the physical sciences than to open a new route, or to continue that which has been trod by other philosophers, setting out from the point where they stopped.

* From the *Journal de Physique*, Fructidor, an. 11.

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The practice which I flatter myself I have acquired in experimental matters has proved to me that, instead of pursuing a direct course, as the greater number do, it is often of advantage to follow a cross road where no one has before passed, or even which no one has ever thought of entering. This is what I have chosen to do in my researches.

In recounting the results of my experiments, I shall not give you the specific names of the objects of them; I confine myself here to generalities alone. I shall only observe, that I employed the eudiometer of that celebrated chemist Giobert to ascertain the chemical alterations of the air: I found it the most convenient, and at the same time the best fitted to my chemico-physiological researches.

I inclosed in a given measure of common air different kinds of worms. It was by this class of animals that I began my researches. I thus learned that those which had organs for respiration, as well as those destitute of them, absorbed all the oxygen of the air, or at least as much as was absorbed by the phosphorus of Kunckel. I observed that in the latter animals the organ of the skin supplied the place of lungs. This novelty induced me to search for another. I was desirous to know whether this organ ceases to absorb oxygen when the worms cease to live; or whether it then still retains this property. To resolve this problem I confined some of these animals, when dead, in close vessels, placing them in the same circumstances under which they were during life: the oxygen was in the same manner entirely absorbed.

Though these animals began to give manifest signs of putrefaction, or putrid fermentation, as appeared by the disgusting odour they emitted, by their change of colour, and the softening of their parts, I put them again into confined air. The fermentation always went on increasing, and the absorbing force was not checked. Having shut up these substances several times in close vessels, I ascertained, by analysing the inclosed air, that the destruction of the oxygen gas was completely and constantly effected by these putrefied matters, from the commencement of their putrefaction until they had attained to the utmost term of it; that is to say, until it was finished, or until they were reduced to a state of almost complete decomposition.

It is well known how much power heat and water acting together have to macerate flesh: this may be easily perceived by ebullition. I tried the latter method also to discover whether this process would take from them or lessen their faculty of absorbing oxygen; but it was preserved in its full

 vigour,

vigour, though the worms were reduced by long ebullition to such a state that their parts scarcely adhered. I subjected to experiment by both these processes different kinds of these animals, which compose the order of terrestrial and aquatic testacea, and the result was always the same. The singularity of this phænomenon made me seriously think that there might be something equivocal in this absorption of oxygen, and I almost conceived the possibility of it.

In each of these analyses, not only the natural proportion of the oxygen gas to the azotic gas was changed, but there was always a certain quantity of carbonic acid gas. I then thought that this gas might be the result of oxygen combined with the carbon of the animal. But in this case it was evident that the animals would not appropriate to themselves the base of the oxygen gas which they diminished. My reasoning acquired strength by an observation which taught me that when, instead of shutting up the animals in common air, I inclosed them in pure oxygen gas, the quantity of that gas destroyed was more considerable; and the case was the same with that of the carbonic acid gas produced.

This observation, however, did not appear to me decisive; because it might have happened that the great quantity of carbonic acid gas arose from a greater affluence of carbonic acid extracted from the animals by a greater quantity of oxygen, which might excite in the animal fibre a strong motion, since it is proved that this substance has a very stimulating force.

The increase of the carbonic acid gas produced by animals placed in pure oxygen gas is not, indeed, constant, since they several times consumed $\frac{50}{100}$ of this gas, while no more than $\frac{5}{100}$ or $\frac{6}{100}$ of carbonic acid gas was observed in this atmosphere. In like manner, by making the experiment with common air, one may see that when its oxygen is entirely destroyed, it is not uncommon to discover in this residuum only two or three hundredths of carbonic acid gas.

To clear up these apparent contradictions, I had recourse to an expedient which ought to be decisive: I placed dead animals in a medium entirely deprived of oxygen gas, because either no carbonic acid gas would be produced in that gas, which would have furnished me with an unanswerable proof that the production of this gas depended on the oxygen of the atmosphere; or, what is the same thing, that it was the effect of the combination of this principle with the carbon

carbon exhaled from the animal, or I should have obtained this carbonic acid gas nearly in the same manner as when the animals are shut up in common air; and then it would be proved that it did not depend on the oxygen of the air, and consequently that it was exhaled immediately from the bodies of these animals in an aëriform state, or in that of carbonic acid combined with caloric and become gaseous.

I therefore shut up different kinds of worms just killed, in pure azotic gas extracted from the fibrous part, well washed from the fresh blood by means of nitric acid, according to the process of the celebrated chemist Berthollet; but in these experiments carbonic acid gas was manifested. I confirmed this experiment by another, in which I inclosed the animals in pure hydrogen gas; and more than once I had a quantity of carbonic acid gas produced in these mephitic gases, greater than when these animals were confined in common air. I was therefore forced to conclude, that the carbonic acid gas produced in these two cases was no way dependent on the oxygen of the atmosphere; and, consequently, that the oxygen gas destroyed by the presence of these dead animals had its base absorbed by them.

I remarked that several animals of this class could live some hours in these mephitic gases. In consequence of this observation I inclosed some of them, provided with organs proper for respiration, in hydrogen and azotic gas; during the same time I shut up other individuals of the same species in common air. The result was, that in these two cases I obtained nearly the same quantity of carbonic acid gas. In these animals, therefore, there was an absorption of oxygen, and the appearance of carbonic acid gas was either a production of carbonic acid gas, or of the carbonic acid, the base of which escaped out of these animals.

But it may, perhaps, be asked, Are worms the only animals which continue after death, or in their state of decomposition, to absorb the oxygen of the atmosphere? This question appeared to me of so much importance that I endeavoured to solve it by experiments on other classes of animals superior to that of worms. I employed insects which always retain the same form, as well as those which pass through the three states of larva, chrysalis, and winged beings. I made my experiments under all these circumstances. But after I had put to death these insects, and followed their decomposition to the end, I always obtained a complete absorption of oxygen when I left for some time the putrefied matters shut up in common air: the absorption occasioned by the dead insects was, however, much

slower than that produced by the living insects, which was effected with singular rapidity.

You will be astonished when I tell you that a larva, weighing only a few grains, appropriates to itself as much oxygen in the same time as an amphibious animal a thousand times as voluminous; and that this considerable absorption is certainly repeated in an enormous manner in the prodigious number of aërian passages disseminated throughout the bodies of these living beings.

I extended these experiments to dead fresh-water and marine fish inclosed in common air. Their size permitted me to make these experiments also on their interior parts after they were separated, such as the intestines, stomach, liver, heart, and ovaria; but all these parts absorbed the oxygen of the air completely, like insects and worms.

One capital point of my reasearches was to discover the proportion of atmospheric oxygen absorbed by dead and by living animals. Water is the natural habitation of fishes; but that which stagnates in a vessel is soon spoiled, and becomes fatal to these animals, though covered with common air; consequently, fish imprisoned in this manner suffer in such a situation, which is disagreeable to them: they come to breathe at the surface, and perish in a very short time. I have seen several die sooner in water of this kind than when exposed in the open air without any water.

From these observations useful hints may be deduced in regard to the chemical changes of the air by which water is covered. I should, however, have been altogether incorrect had I adhered to this method only: I therefore added to it a better, by placing the vessels in which I kept these fishes in a stream of running water, by which means the water in the vessels could be continually renewed. By this method I was able to obtain with more precision the proportions indicated.

I observed in amphibious animals after death the same phænomena as those exhibited by worms, insects, and fishes; but living amphibia gave me other results. I had observed that several of them survived for some days the destruction of their lungs; which furnished me with an opportunity of submitting them in that state to my experiments, and to remark the precise absorption of the oxygen made by the lungs and by the organ of the skin. I was thus enabled to form a comparison between the oxygen absorbed by these mutilated animals and by those which had not been treated in the same manner.

You will see in my book how small is the absorption of oxygen

oxygen by the lungs in comparison of that absorbed by the skin, though it has been generally believed that in this class of animals, as in others which are higher, the destruction of the oxygen gas of the atmosphere ought to be referred entirely to this organ. Some kinds of amphibia also which I deprived of their lungs lived much longer in the open air than those which had lungs when I inclosed them in mephitic air, where they were entirely deprived of oxygen gas. I discovered also that some of them die much sooner when their skin is slightly covered with a spirit of wine varnish. The cause of this difference is evident: by means of this varnish these animals then not only cease to absorb oxygen, but they can no longer free themselves from the carbonic acid which ought to be exhaled, and its expulsion is necessary to their existence; while in the mephitic gases in which I placed these animals I always found carbonic acid in its gaseous state.

I was, however, able to ascertain the exact absorption of oxygen by the cutaneous organ, without depriving amphibia of their lungs: I confined their bodies in receivers in such a manner that they had no communication with exterior air, while at the same time they had their heads out in the air, in which they could freely breathe. I thus clearly ascertained, that the absorption made by these animals when dead is only a continuation of that which they made during life.

Hitherto I have spoken only of the four classes of cold-blooded animals; it therefore remains that I should say something of birds and the mammalia: as the latter have a greater relation to man, they ought to be more interesting to our curiosity. Birds also absorbed oxygen in the experiments to which I subjected them, both when living and dead; and even their parts, such as the brain, muscles, interior parts, and also the skin. I shut them up alive, like the amphibia, in vessels in such a manner that they breathed in the open air without these vessels; which furnished me with the means of ascertaining the quantity of the absorption by the cutaneous organ.

The mammalia, who are in the order of quadrupeds, gave me results similar to those exhibited by birds; but I obtained others of great importance from that singular species of quadrupeds which are rendered lethargic by the air, or which, as is commonly said, sleep during the winter.

I observed that the phænomena of respiration change in these animals according to the different degrees of the temperature of the atmosphere, and that similar phænomena are

 remarked

remarked in the circulation, in consequence of the great affinity between these two functions. Being desirous to examine them thoroughly, I kept in my house for five years the five species of these animals found in Italy. By making researches in regard to their respiration I had still another object in view, which was to study the habits of this class of animals, and every thing that might be interesting to their history, because too little known, or not sufficiently explained. Having, therefore, near me this great number of animals, and having observed them during different seasons of the year, and seen them in their natural retreats, I was able to accomplish my plans as I wished.

As the event must be curious, you will remember my marmot, which was so lethargic during the severe winter of 1795; I then kept it for four hours in carbonic acid gas, the thermometer marking — 12°. It continued to live in this gas, which is the most destructive of all: a rat, at least, and a bird which I placed in it perished in an instant. It appears, then, that its respiration was suspended during that time. I submitted to the same experiment bats which were in the same lethargic state, and the result was the same. I then continued my experiments. I preferred these flying animals to the marmot, apprehending that this animal might fall a sacrifice to these trials and perish, because I had only two, on which I had other experiments to make, whereas I had in my possession a great number of bats.

I was therefore desirous to know, whether when respiration was suspended in these animals a production of carbonic acid would be effected by the organ of the skin. I then substituted azotic for carbonic acid gas, in order that the result might not be doubtful. I placed in this gas two bats, the thermometer being at — 9°. At the end of two hours I took them out, and having gradually introduced them into a warmer medium, they gave evident signs of life: but I found no carbonic acid gas in the azotic gas; which made me conclude that this temperature was too low for the exhalation of it. I continued these experiments at a temperature successively higher to — 3, by which means $\frac{5}{100}$ of carbonic acid gas were produced, though the lethargy of these animals was still strong.

In this state of things I repeated the experiment under the same circumstances, only I removed the bats into another vessel full of common air; but I then found not only the production of $5\frac{1}{2}$ hundredths of carbonic acid gas, but also the destruction of 5 hundredths of oxygen gas. Though these two small quadrupeds were in respirable air, their profound

found lethargy prevented them from profiting by it. They did not absolutely respire; that rising and falling occasioned in their flanks during respiration was not remarked; the case was the same in the open air. It is therefore evident, that this partial consumption of oxygen gas was the consequence of the absorption of this substance by the cutaneous organ.

It thence results, that this chemical power of absorbing the oxygen of the atmosphere belongs to these cold-blooded animals when dead, and that when living they exhibit the same power, which is continued even when their bodies are in a state of decomposition.

In a word, this total suspension of respiration experienced by these animals when exposed to a violent cold, becomes unsupportable to them and occasions their death, as I have seen in my experiments; so that this state of lethargy into which they fall when in their burrows, which happens to some small animals, and in general to amphibia, is always accompanied with a weak principle of respiration, as I shall show in its place in my work.

Several worms, and among them the greater part of the testacea; many insects, among which systematic writers place the crustacea; besides the immense family of fishes, have their residence always in the water, and sometimes cease to live in it. Will the faculty they have of appropriating to themselves oxygen when they remain exposed to the air, be maintained in that fluid, because it is mixed therewith a quantity of oxygen gas? I was inclined to think so; but to assure myself of it, I made direct experiments.

With this view I placed different kinds of these animals when dead in tubes filled with water, above which I caused a given measure of air to ascend. The oxygen gas of the water communicated with that of the air. It appeared then clear to me, that if the former were absorbed, the second, or at least a part of the air, without the water in the tube, ought to replace that kind of vacuum which might be produced in it, and re-establish the lost equilibrium. This took place; and I must observe, that every time I made the experiment on several individuals of these three classes, though the experiments were very numerous, the air which covered the water was deprived of its oxygen gas.

I must mention also another observation which I made. When, instead of these aquatic animals, I placed at a given depth under the water terrestrial animals, or their parts, I obtained the same destruction of the oxygen gas of the air placed above it. This proves that the property which these

animals have of absorbing oxygen in the air, is retained by them in the water, though not destined to live in it, and though it be fatal to them.

Hitherto I have spoken of the organ of the skin, and shown in the six classes of animals, that it has the power of appropriating to itself the oxygen of the air, not only when these animals are alive, but even after they are dead. I wish to call your attention for a moment to this power communicated by nature to other parts, which, though essential to their œconomy, present themselves to the air as if they were only accessary. I here allude to the shells of the terrestrial and aquatic testacea: they belong, as you know, to the family of worms.

When I observed that these dead animals decomposed common air by absorbing its oxygen, I imagined that the shells might contribute to this operation; because I considered that they were organized according to the demonstration of Herissant, and that they formed a whole with the animal which inhabited them. It was easy to verify this idea by inclosing the shells alone in common air, and the effect showed that my conjecture was well founded. This absorbing faculty is manifested also in the testacea which inhabit the earth, and in those which sojourn in the waters. I was able to estimate the quantities of oxygen absorbed by the animals alone and by their shells; only I remarked, that the absorption produced by the shells was slower than that by the animals.

While engaged with these experiments, analogy suggested to me the idea of a body which was indeed of a different kind, but which seemed worthy of attention. The shells of the testacea are formed by two substances, one terreo-calcareous, the other animal. The shells of the eggs of birds are formed of these two substances; Is it not possible, or rather probable, thought I, that this absorbing principle may reside only in these coverings? I actually found it in the shells of all the eggs which I subjected to experiment; and as I have a proof that a part of the oxygen absorbed by the shells of testacea passes into the animals which inhabit them, it is probable that it concurs to the preservation of their life. I think I have proofs of this sufficiently strong to show the passage of the oxygen gas into the interior part of the egg in order to vivify it, and to concur to the development of the germ it contains.

I cannot leave these considerations on the shells of testacea and of eggs, without throwing some light on a point inseparable from their nature. Their constituent principles, as we

we have seen, are an organic tissue, and an earth entirely calcareous. Is the absorption of the oxygen of the atmosphere, however, produced by these two substances, or by one exclusively of the other? I at first thought, that, to obtain a solution of this problem, it would be necessary to subject both to experiment; and I began with the calcareous matter, because it could be easier employed for that purpose. As it had all the essential relations with carbonate of lime, I was enabled to ascertain, with great convenience, whether it possessed this absorbing power: in that case there was reason to conclude, that the carbonate of lime of the shells had the same; but if carbonate of lime did not possess this faculty, it was clear that the absorption of the air by the shells did not arise from the calcareous but the animal part, and this is what I concluded; because the purest carbonate of lime, crystallized and transparent, calcareous spar, kept a long time immersed in common air, does not occasion in it the least alteration.

I had a striking confirmation of this by some shells of the *helix pomatia* and the *helix nemoralis*, which I found by chance in the garden, and which appeared to me to have been a long time deprived of their inhabitants, as I judged from their being worn, and from the alterations they had experienced: they had become lighter, and easily broke, or were reduced to powder, between the fingers. The calcareous matter refound by means of acids and fire, left me no doubt in regard to their nature. I however found that they had lost a great deal of their power of absorbing oxygen, and that this loss was greatest in the shells which had been most disorganized. It must therefore be admitted, that the organization of the shells of testacea is the cause of this absorption, independently of the calcareous matter, or at least that without this organization the shells could not produce that effect. In like manner, if these shells are preserved in such a manner that they are not sensibly decomposed, even though kept several years, they still retain their active property of speedily absorbing oxygen.

Such, my learned friend, are the principles of which I was desirous to communicate to you some idea. Though the pulmonary respiration of this numerous species of animals has been the principal object of my experiments for several years, I wished only in this letter to give you a hasty sketch of them, in order to show how living animals continually consume oxygen gas in a manner independent of the lungs, and how they destroy it even after their death: you have seen it in cold-blooded animals, as well as in worms

worms, insects, fishes, amphibia; and in warm-blooded animals, I mean birds and mammalia, this destruction in a given proportion of common air is complete, at least as far as can be shown by Kunckel's phosphorus.

In speaking of mammalia, I made, on purpose, several experiments on certain parts of their bodies, such as the muscles, tendons, bones, brain, fat, blood, and bile. Each of these parts destroys the oxygen gas in different proportions, except the bile, which appears to be incapable of that operation; but the blood is not the only one of the animal parts most proper for the destruction of oxygen gas; though I first believed that, in this respect, it was superior to them all, judging from what has been written on the blood in regard to the decomposition of the air. The blood of cold and warm-blooded animals, the venous as well as the arterial, have been subjected to experiment, and I had no variation in the results.

In the beginning of this letter I expressed my doubts on the consumption of oxygen gas, occasioned by worms shut up in common air: Is it produced by the absorption of its base, or rather by its combination with the carbon which is exhaled from these animals? I found the carbonic acid in the vessels contained in these animals, and this carbonic acid must have some source, since the vessels are full of it; but this doubt was removed by showing the appearance of this gas, though the worms were confined in azotic and hydrogen gas. I observed the same thing in the five other classes of animals; so that I think myself authorized to assert, from the fact in the experiment with oxygen gas, that this gas abandons its base to the cutaneous organ of the animals, which absorb it as well as the different parts of their bodies.

But you will perhaps ask, Whether the azotic gas of the atmosphere suffers any chemical alterations in so great a multiplicity of experiments?—I shall observe in answer, that I never made any without considering this gas, and without finding that, according to the varieties of the animals, it sometimes remained untouched, and at others experienced some diminution; but that it was always very small in comparison with that of the oxygen gas, though the latter is scarcely equal to a fourth of the former in common air.

I then saw that the chief direction of this animal absorbing force is to take away and appropriate to itself oxygen: it has a direct relation with the temperature of the atmosphere, so that it may almost be established as a general rule, that

that the absorption of oxygen is directly as the heat of the ambient air in which animals reside; and this accords very well with the observations made on phosphorus.

In these results, which I have made known to you in so brief a manner, because I reserve the accompanying proofs for my work, you see the immense consumption made of oxygen gas by animals at the expense of the air; that by the lungs, or other analogous organs, is no doubt great, but it is still immensely increased by the absorption occasioned by the exterior surface of the body; and it is the same in animals furnished with organs proper for respiration and in those which are deprived of them: nay more, when animals which respire cease to live, the destruction of oxygen gas, which no longer takes place by respiration, continues by the organ of the skin, and even increases in regard to some animals when putrefaction is far advanced. If we take into consideration the incalculable number of animals which peoples every part of the globe, whether they inhabit the land or the water, it would appear that the oxygen gas, which forms the most valuable part of the air, must have decreased, and produced the destruction of the organized kingdom. We are, however, taught by eudiometric observations, that the mass of the oxygen gas of the atmosphere remains unalterably the same. We must therefore necessarily conclude, that nature has means of compensating exactly for this infinite destruction of oxygen gas, in the same manner as it does for maintaining an exact balance between the death of vegetables and animals and their re-production.

But in what manner does nature effect this compensation? You and Ingenhousz have shown it by the publication of two works which display the originality of their authors, and which form a luminous epoch in natural philosophy. It may be readily seen that I here allude to what you both have done to show in what manner vegetables exposed to the solar light pour out into the atmosphere a prodigious abundance of oxygen gas. It certainly appears proper for repairing that loss of oxygen which may be occasioned by the pulmonary organs; but as this loss is still greater, since we must add to it that produced at the surface of living animals, and by these animals themselves after death, I cannot say whether these losses can be compensated in whole by plants, especially as the number of animals is much greater than that of plants. As this great consumption of oxygen is made by animals during their whole lives, and for some time after their death, and as plants do not dif-

 fuse

fuse that beneficent influence into the atmosphere but at certain determinate seasons, or only when they are green; these reflections induced me almost to think that it would be necessary to seek for some other constant source of this vital gas: I am consequently of opinion, that as nothing in nature is lost, animals themselves may have the means of restoring to the atmosphere that oxygen of which they deprived it.

But this is not the time for entering the field of conjecture in regard to this important subject; I shall discuss it in my work on the respiration of men and of animals. For the present I shall tell you that I have finished the composition of four memoirs, which will form the first part of my researches, and which will soon be published.

XLII. *A full Description of the Method of preparing Mr.* GEORGE BLACKMAN'S *Superfine Oil-Colour Cakes; as communicated to the Society for the Encouragement of Arts, Manufactures, and Commerce, and practised by him in Presence of a Committee appointed by the Society to ascertain the Merit of the Invention*.*

TAKE of the clearest gum mastic, reduced to fine powder, four ounces; of spirit of turpentine, one pint; mix them together in a bottle, stirring them frequently till the mastic is dissolved: if it is wanted in haste, some heat may be applied; but the solution is best when made cold. Let the colours to be made use of be the best that can be procured, taking care that, by washing, &c., they are brought to the greatest degree of fineness possible. When the colours are dry, grind them on a hard close stone (porphyry is the best) in spirit of turpentine, adding a small quantity of the mastic varnish: let the colours so ground become again dry; then prepare the composition for forming them into cakes in the following manner:—Procure some of the purest and whitest spermaceti you can obtain; melt it over a gentle fire, in a clean earthen vessel; when fluid, add to it one-third of its weight of pure poppy oil, and stir the whole well together: these things being in readiness, place the stone on which your colours were ground on a frame or support, and, by means of a charcoal fire under it, make the stone warm;

* From the twelfth volume of the Transactions of the Society, who voted the greater silver pallet and twenty guineas to Mr. Blackman for discovering his process for the use of the public.

next

next grind your colour fine with a muller; then, adding a sufficient quantity of the mixture of poppy oil and spermaceti, work the whole together with the muller to a proper consistence; take, then, a piece of a fit size for the cake you intend to make, roll it into a ball, put it into a mould, press it, and it will be complete.

When these cakes are to be used, they must be rubbed down in poppy or other oil, or in a mixture of spirit of turpentine and oil, as may best suit the convenience or intention of the artist.

The abovementioned oil-colour cakes were tried after they had been in the possession of Mr. Cosway and of the Society for twelve months, and were found to possess the same valuable properties they had at first.

Mr. Cosway says that he made several experiments with these colours, and is of opinion that the manner in which they are composed is a new and useful discovery; and the great advantage they possess of drying without a skin on the surface, is a very essential improvement on the usual mode of oil-painting, particularly for small works.

Mr. Stothard says, one advantage these colours possess above others is, they must be very convenient to travellers, as they are always fit for immediate use, they not drying hard nor skinning over.

Mr. Abbot says he has frequently used colours prepared by Mr. Blackman, particularly his red lead, which, as far as he can judge, is better preserved from changing by this method of preparing, than by any other he has met with; and as the tint given by red lead is peculiarly adapted to the highest lights of flesh, more especially on the forehead in portrait-painting, he thinks Mr. Blackman's discovery, if it fully answers that purpose, a very advantageous one to artists; that he has so good an opinion of Mr. Blackman's ingenuity and merit on this head, that he has ordered a set of colours prepared in his manner, in bladders, for his own use.

N. B. It may here be proper to observe, that Mr. Blackman's colours in bladders are prepared with a mixture of spermaceti, and differ from his cakes only in having a larger proportion of oil.

XLIII. *De-*

XLIII. *Description of an improved Crane for Wharfs. By Mr.* Robert Hall *junior, of Basford, near Nottingham.*

Forty guineas were voted to Mr. Hall, by the Society for the Encouragement of Arts, &c., for his ingenious invention of a method to *expand a set of bars parallel to the axis of a crane,* by which means the velocity of the rope in raising weights may be increased or diminished in proportion to the load to be raised.

A description and engraving of this crane are given in the twelfth volume of the Society's Transactions, from which we have drawn up the following account of it:

The ends of the reel (fig. 1 and 5. Plate IV.) consist each of two flat plates or circular pieces, shown separately in fig. 2 and 3. These circular plates form the two ends of the reel, and are held fast on the spindle or axis by pins passed through its ends, of which one may be seen at *a,* fig. 2, and another in the end shown in fig. 5. The outer circular plate (fig. 3.) of each end of the reel has a spiral groove cut in it, as shown at *b,* and the inner circles have each eight mortices cut quite through them, as shown at *c,* fig. 2. (seen partly also in fig. 1 and 5.) The outer plates have also an iron tube, *d,* made fast to them by means of a flange or collar, and the screws, *ee,* fig. 2.

When the parts are all joined, (as shown in fig. 1.) the axis *f* passes through the tube *d,* and thus the ends are connected. In fixing the cross bars, two of which are shown detached in fig. 4, the parts *g,g* slide in the mortices *c* of the inner circular plates, and the small ends or tenons *h,h* go fairly through the inner and enter the spiral grooves of the outer plates.

The inner and outer circular plates are locked together by a catch (*i,* fig. 1, 2, and 6.) the stationary part of which is made fast to the inner plate (see fig. 2), while the catch itself, by means of a spring, is kept in a notch on the edge of the outer plate. When the diameter of the reel is to be enlarged or diminished, it is effected by bringing the reel round to the position shown in fig. 6, when a hook, *k,* is put into a hole, *l,* which keeps the inner circular plate in that position till the adjustment is made by lifting the catch from the notch of the outer end-plate far enough to be kept disengaged by the hook *k,* before mentioned, being thrust quite through the hole *l:* the handle *m* being then turned, the outer plate only is carried round, and the tenons or small ends of the cross bars (being prevented from being carried

carried round with it, by the mortices of the inner plates through which they pass being stationary) are obliged to change their distance from the axis by the spiral groove sliding over them, while they are able to move nearer or further from the axis by sliding in the radial mortices of the inner end-plate.

The handle *m* being turned till the reel is of the size required, the hook *k* is withdrawn or pushed out, and the crane is then ready for work.

It is necessary to observe that the tenons *h*, *h* must be cut, so that the outside of all the bars next the rope shall be at an equal distance from the centre. If the tenon of the first bar that is placed in the reel be cut like the tenons *h*, *h*, fig. 4, the last of them must be cut the same as the tenons *n*, *n*, fig. 4; and all the other tenons, at the extremities of the several bars, must be at proper distances between these extremes, as is shown by the dots P in the mortices fig. 2.

The other parts of the crane may be so easily understood from an inspection of the engraving, that any further description is unnecessary.

XLIV. *Description of an improved Bucket for drawing Water out of deep Wells. By Mr.* George Russel*.

The silver medal of the Society for the Encouragement of Arts, &c., was voted to Mr. Butler for this invention, of which a model is reserved in the society's repository for the use of the public. The following is Mr. Butler's account of the improvement:

"My well at Downe, in Kent, is about 360 feet deep, and is worked by two buckets and a horse-wheel, each bucket holding little less than a barrel; and are the same sort of buckets, with the same mode of emptying, as at Dorking, Dover, Hasted, and all the deep wells I have met with.

"The great weight of iron on those buckets, to make them sink immediately on descending to the water, being observed, together with the heavy flat iron chain by which they are hung to the rope; and which, passing over a flat-grooved wheel above, brings the face of the buckets properly to the cistern-catch, suggested the following idea:

"A valve of five inches diameter was put into the lower

* From the *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, vol. xii.

head

head of a common light beer-barrel; a cross was placed in the centre of the top of the barrel; it was then let down into the well by a rope; it filled through the valve in the bottom, and came up very steady and full, with scarce any drip: what little drip there was, fell immediately down the well from the valve in the centre of the bottom without wetting the descending rope, such wetting being very prejudicial to the rope, as in use with the old buckets; for by the nature of their bails they ascend swinging, sometimes strike in passing, and by splashing over the sides are never full.

"Two buckets on the new construction were immediately made with iron hoops as light as possible; they have worked four years without being out of condition; the hoops, chains, &c., of these buckets weigh less than the old ones by two hundred weight. The well-rope is little more than half the size and cost; a much greater quantity of water is raised in an equal time, and the labour of the horse much relieved."

Description of the improved Machine.

A A, (Plate V.) two posts fixed in the curb of the well, opposite each other, and grooved within to receive the ends of the collar.

B, two parallel bars which bear down the small iron arms or cross, R, as the bucket ascends, and open the valve to discharge the water.

C C, the collar resting on pegs in the groove; and, being lifted by the bucket in ascending, communicates, by a rod or line down the groove, with the short end of the moveable bars at D: the short end of these bars, which work on a pin or fulcrum at E, being so moved, draws forward the trough, F, with an increased velocity, by means of the lines passing from it over the pulleys G G, and fastened to the long end of the bar at H; by this action the trough runs under the bucket, and is ready to deliver the water into the cistern I, when the valve Q (which is about five inches diameter) is opened by the cross L, striking the bars at B.

F, the trough, moving on four brass rollers, which, on the water being delivered, runs back, as the bucket descends, with the same velocity as it was drawn forward: this is done by means of the weight K, hid within the lining of the model, and connected by a line, passing over a pulley in the frame above, to the centre of the hinder part of the trough.

L, two thin pieces of iron fixed across the top of the bucket;

bucket: in the centre of these pieces is placed the small iron standard M, on which is a collar with four arms N, made to move up and down: above the collar is a small brass pulley in the mortice O, in the upper part of the standard, and a loop to which the well-rope P is made fast: to one of the arms of the collar is tied a cord, which passes over the brass pulley above, and then down to the lip of the valve; so that the cross L, being pressed against the bars B, is forced downwards, the cord drawn up, and the valve opened.

XLV. *An Examination of Dr.* Wollaston's *Experiment on his Periscopic Spectacles. By Mr.* William Jones, *F. Am. P. S.*

To Mr. Tilloch.

SIR,

The inferences that Dr. Wollaston has thought it best to publish in your last month's magazine, instead of a direct reply to my refutation of his new principle of spectacle glasses, are of themselves sufficient to convince any impartial person of the validity of the objections advanced by me in your preceding number; and, notwithstanding an extraordinary experiment he has therein related, as made only by himself, I should not have thought it requisite to trouble your readers again, but for the unfounded imputation he has declared against me, that of having, by an experiment, deceived myself. I trust, sir, I may be allowed, in contradiction to this, to observe, that after more than twenty years experience in the practice of my profession, such as daily administering to decayed vision, and employment in the construction of all kinds of optical instruments, I should not be acquainted with the various properties of lenses, singly or combined, and especially of so simple and well known a form of lens as adopted by him, is an idea that I am confident he cannot impress upon the mind of the public. I suggested no new experiment, nor was any one wanting; the definitive laws I adduced were contained in the works of the best writers on optics, and were sufficient to evince the want of originality and improvement of his meniscus-shaped lens. In respect to the experiment by which he attempts to enforce a proof of an advantage in his spectacles, its value will be known by the following account of a repetition of it. I am possessed of a pair of his peri-

copic glasses mounted in a single steel frame, which cost 10s. 6d. The glasses, I must observe, are very different to his proposed form, having of each, the inner side, or that next to the eye, so little incurvated, that by any person but an optician they would be called plano-convexes. The focus is 4 inches, the same as used by Dr. Wollaston in his experiment. In a similar mounting, with double convex glasses of the same diameter and focus, I provided a pair of our own manufacture, and as sold by us at 3s. 6d. These two pairs of spectacles were attentively compared together by myself and several judicious and impartial persons, in the manner as stated by Dr. Wollaston of his; the result was as follows:—The convex glasses being applied as close as possible to the eyes, the print of a large quarto page was viewed through them at a distance for distinct vision at their centres: the letters, at the distance of about 25 lines, appeared quite distinct, or well defined. Giving the axes of the eyes a little obliquity, to discriminate more lines, an indistinctness or confusion of letters commenced, increasing towards the extremity of sight; and from the lateral aberration of the lenses the letters were tinged with the prismatic colours. Keeping the head fixed in the same position, the periscopic glasses were substituted. The extent of distinct letters without distortion was nearly as great, but the coloured letters were evidently nearer to the centre, and more numerous than by the other glasses. By inclining the axes of the eyes still more than in the former case, or looking extremely asquint through the glasses, a greater extent of lines was observed, but blended with colour and confusion. The optic nerves felt a sensible irritation, evidently from the squinting position of the eyes, a refraction of many superfluous rays, and the consequent increased and unusual magnitude of the images on the retina. The pain in the eyes mentioned by Dr. Wollaston must have arisen only from this circumstance, and not from the one he represented it to be. By a trial of the old meniscus I before mentioned, which is four inches focus, and corresponds with what he has a patent for, in comparison with the above plano-convexes, the view of the letters was still more extended, but illegible and with much colour, and like the other, towards the extremity, of no sort of use for the purposes of vision.

Now all this is conformable to the laws of optics, and manifests a property different to that advanced by Dr. Wollaston.

These

These several glasses are also at the public service for inspection in our shop in Holborn.

By making the glasses of the above periscopic spectacles nearly planos, Dr. Wollaston's principle is destroyed, and my opinion evidently verified: that the nearer a meniscus approaches to a plano, the more perfect it will be, as the spherical surface for the same focus is diminished, and consequently the aberration. Besides, admitting that there were any advantage derivable from a great obliquity of the axes of the eyes to those of the meniscus-shaped spectacle glasses, I would ask, For what reason has man his head moveable? Was it not that he should place his eyes directly before the object to be viewed, and not subject himself to fallacious ideas of them by an awkward and revolutionary squinting?

From what I have advanced I doubt not of the public decision (from a fair comparison of the two kinds of spectacles) in favour of the established double convex spectacle-glasses: for

"Magna est veritas, et prævalebit."

I am, sir,
Your respectful humble servant,
WILLIAM JONES.

Holborn, April 10.

XLVI. *Memoir on the Culture of the Anatto Tree, and the Preparation of Anatto.* *By* C. LEBONE*.

THAT colouring matter known under the name of anatto is the produce of a tree brought originally from America, and called by botanists *Bixa orellana*. It approaches near to the family of the *tiliæ:* it rises in good soil to the height of from fifteen to twenty feet, and its branches form a circumference of from nine to twelve feet radius. It flowers at the age of eighteen months; and its flowers, which are attached to a common pedicle, are succeeded by capsules covered with soft points. The seeds are surrounded by an orange-coloured pulp, employed in dyeing. The anatto tree is cultivated in French Guyana; it is multiplied by slips or plants: the former last longer; the latter produce sooner, and live for seven or eight years. They are planted in parallel lines, at a distance which varies from twelve to twenty-four feet, according to the diameter which it is supposed the tree will acquire in the ground destined for it. The anatto trees

* From the *Moniteur.*

require continued care: when young, their delicate roots must be covered with earth; when green herbs are heaped up about the bottom of the trees they often cause them to perish, in consequence of their fermentation. It is customary to beat down the first flowers, that the tree may not be exhausted by premature fecundity. The earth is dug up around the tree with a hoe, but care is taken not to touch the roots. When the rains have been abundant, the planters are satisfied with cutting the grass in the neighbourhood of the tree with an instrument like a scythe, which spares the roots, and accelerates the labour. A sickle might also be used.

The anatto tree is injured neither by heat nor by rain; it prefers low humid places, and is not attacked by caterpillars, but is very subject to the *guy* (a name given in Guyana to a sort of *loranthus*): it ought to be carefully freed from that parasitic plant, which prevents it from bearing the usual quantity of fruit.

The anatto is fit for being gathered, if the capsules, when pressed between the fingers, open with an explosion: the product is collected with the hand, and the negroes who gather it deposit the capsules in barrels, which when full contain about thirty-five pounds. The product of the trees varies according to the age, the season, and the soil. From 1500 to 2500 pounds are collected in eighteen months from 1800 square yards, when the land is good: at the end of three years the product is still more considerable; at five years it begins to decrease, and at ten years the quantity collected will scarcely defray the expense. To separate the grains, the capsule is opened with the thumb and fore finger; the person then lays hold of the membrane to which the seeds are attached. This labour is in general entrusted to the more delicate hands of women and children: the negroes of Africa employ for this purpose a kind of spatula.

After the produce is collected, the next operation is to separate the colouring matter. Under a kind of shed supported by forked sticks fixed in the ground, covered with leaves and open on all sides, are placed a kind of troughs cut out in the trunks of trees, in which the grains of the anatto are heaped up. The first trough is called the pounding trough, the second the immersing trough, the third the discharging trough, and the fourth the straining trough. These names indicate the different uses to which they are applied. Each pounding continues half an hour: a negro pounds about sixty or seventy pounds per day. This operation is performed so badly that many of the grains are still

still in a state of seeds when thrown away as useless. An attempt has been made to introduce machinery for this purpose, but it has been abandoned without sufficient reason.

When the grains are pounded in the first trough they are carried to the immersing tub, where they are diluted in a quantity of water sufficient to cover them, and in which they are left some months until they are pressed. The matter is pressed in sieves, which are placed above the immersing trough, that the water which holds the colour in solution may fall into it. The grains are then carried to the discharging trough, and covered with leaves: they are left in that situation till they ferment; they are then put in succession into the pounding trough, the immersing trough, &c. till they contain no more colour. When no more seeds remain in the immersing trough the colour is diluted with water, and women make it pass through sieves placed over the straining trough, in order to separate the remains of the seeds. This operation is performed badly, and in a slow manner. The matter which has passed through remains in the trough till it has deposited the colour; which is generally the case at the end of fifteen days, or sooner when the weather is cold or damp. The water from which the colour has been precipitated is carried back to the immersing tub to dilute other seeds, because it has been observed that it accelerates the fermentation better than pure water.

When the anatto has been precipitated, which is known by the liquor being uncoloured, it is boiled in kettles, stirring it continually until it is reduced to the state of paste. When cold it is spread out in boxes to the thickness of from eight to ten inches, and is dried in a place sheltered from the sun, which would blacken it. When it is so dry that a mass of about fifteen pounds can be taken up by thrusting the hand into it, it is put into baskets lined with leaves, and carried to market. Each basket weighs about seventy pounds.

When about to be put into casks, cakes of the diameter of the cask are formed upon leaves of the *balalou*, and they are pressed into the cask till it is full. The cask ought to weigh from 300 to 350 pounds, and to contain no more than $\frac{6}{100}$ of leaves. But on such occasions a great number of frauds are committed: on this account government formerly appointed commissioners to verify the quality of the anatto. They took a determinate quantity, which they washed several times; and if the residuum exceeded a twelfth part the anatto was rejected. The goodness of it is tried also by rubbing a little of it on the nail: if after being

washed and soaped there do not remain a red spot, which is called *mordant*, the anatto is considered as of no value.

Such is the process employed for the fabrication of anatto. The author of the memoir remarks that this tedious, laborious, and unhealthful operation gives an uncertain product of a bad quality. He proposes merely to wash the seeds till they are entirely freed from the colour, which is placed at the surface; to make the water pass through fine sieves, to separate the remains of the bark, to precipitate the colour by means of vinegar or lemon juice, and to bake it in the usual manner, or to make it drain in bags, as is practised for indigo*. This process is founded on this circumstance, that, as the colour is entirely at the surface of the seeds, it is needless to bruise the latter, and to reduce them to a state of putrefaction. This method would be advantageous to the planter who may wish to save hands; to the merchant, who would gain in regard to the freight; and to the dyer, who, being sure of the quality of his colouring matter, would be enabled to determine with exactness the quantity necessary for his purpose. If the planters of Guyana refuse to change their process, it might be advantageous to send to Europe the seeds without preparation. The saving in the manipulation would be equal to, and even surpass, the expense of carriage. The annual consumption of anatto amounts to 240 tons. When the crop exceeds 280, the price of this article, the use of which is limited, falls so much that the cultivation of it ceases to be advantageous.

XLVII. *Observations on the Possibility of collecting a certain Quantity of Succinic Acid during the Process of making Amber Varnish, without lessening the Property of the Varnish. By M.* Planche, *Member of the Pharmaceutic Society of Paris*†.

Having had occasion to assist some time ago in the preparation of amber varnish on a large scale, I observed that during

* Jussieu, Desfontaines, Cels, and Vauquelin, commissioners of the National Institute, have verified the excellence of this new process. The anatto which thence results is less mixed with impurities, and consequently of a finer tint; so that one part of the anatto extracted by simple washing produces the same effect as four of common anatto. This fact is confirmed by a certificate from C. Ducuret jun. and Genet, dyers at Paris. They add also that this anatto is more easily employed; that it requires less solvent, and gives a purer colour.

† From the *Annales de Chimie*, No. 145.

during the operation, and until the heated substance had acquired the proper degree of fluidity, a great deal of succinic acid was disengaged.

Every artist has had an opportunity of making the same remark; but whether they mistook the real nature of this salt and its properties, or considered it only as essentially inherent in the quality of the varnish, no one has hitherto attempted, as far as I know, to derive any advantage from it. Those, however, would be in an error who should infer from what has been said, that good varnish ought to be free from succinic acid: on the contrary, it is very probable, that on the addition of drying oil and essence, which ought to increase the fluidity of the amber, this matter can still furnish some of it, and even in abundance.

I should deviate from the real object I have proposed in this notice, were I to relate the different processes employed in the preparation of this varnish: I shall only observe, that as this operation is performed for the most part with the contact of the air, and over an open fire, and in varnished earthen vessels, the aperture of which is from four to five inches in diameter,—when the matter is sufficiently penetrated by caloric, a part of the succinic acid, become free, is exhaled as mere loss into the atmosphere, while a very large quantity is fixed to the sides of the matrass, under the form of very fine delicate needles, sufficiently white to have no need of purification*. Each matrass, containing twenty-four ounces of amber, (a common dose,) can furnish from eighty to ninety grains of acid, without in any manner lessening the quality of the varnish †. It is proper to observe also, that one ought to seize the moment when the succinic acid is disengaged, to separate it; and this disengagement takes place a little time before the addition of the oxygenated or drying oil. If the operation be deferred, the greater part of the product will be lost. The motion indeed necessary to be given to the spatula, to effect the mixture of the oil with the amber, detaches a great deal of volatile salt. All hope, therefore, of collecting it must be lost when essence of turpentine is added; as this oil, vaporized by the

* The acid obtained by the first operation is indeed very pure when the vessel is new, but in the subsequent operations it becomes more coloured. Recourse may be had to the processes of purification indicated by Pott. Artists will find it of advantage to employ matrasses of copper: as these vessels are easily cleaned, they will always furnish the same product.

† I ascertained this fact by several experiments, performed both in my own laboratory and in that of M. Tonnelier, coach-painter, who is exceedingly well versed in this branch of the arts.

heat of the mixture, which sometimes swells so as to run over the vessels, causes the succinic acid to disappear entirely.

However minute the means I employed to extract the succinic acid may appear, I thought it necessary to describe them. I first conceived the idea of separating it with a card: this process succeeded pretty well; but in this case one is exposed to the danger of being burnt. I employed with more advantage a spoon of tinned iron, which is different from the usual form only in being semicircular, not so concave, and proportioned to the size of the vessel. It terminates behind in a thin plate of iron, which, exceeding the edge by some lines, represents a sort of band, from which arises, at right angles, a handle of the same substance, fifteen inches in length. This form appeared to me most convenient; first, because, by applying it exactly against the sides of the vessel, it prevents the salt, which is detached by instantaneously removing it, from being mixed with the fused amber; secondly, because it offers to the artist the means of operating, without being so much incommoded by the vapours disengaged from the matter.

It results from what has been said, that artists who prepare amber varnish may in future, without making any change in the apparatus or in their process, obtain a considerable quantity of succinic acid, which, though hitherto confined to medicinal purposes, may soon be rendered useful in the arts. Some trials already give reason to hope that an alcoholic solution of it may be employed for imitating the colour of certain valuable kinds of wood.

XLVIII. *Notices respecting New Books.*

The Painter and Varnisher's Guide; or, A Treatise, both in Theory and Practice, on the Art of making and applying Varnishes; on the different Kinds of Painting; and on the Method of preparing Colours, both simple and compound, &c. By P. F. TINGRY, *Professor of Chemistry, &c. in the Academy of Geneva.* 8vo. 540 Pages. Kearsley, Fleet-street.

We have perused this work with great satisfaction; it contains much new, useful, and interesting information on the different subjects which it embraces, and cannot fail to be highly serviceable to artists. We think the publisher has rendered

rendered a real service to the arts in this country, by giving an English translation of it. The translation is a good one.

In our future numbers we shall give some extracts from this work, which has been highly recommended by M. Senebier, who was appointed to examine it by the Society at Geneva for the Encouragement of Arts.

XLIX. *Proceedings of Learned Societies.*

ACADEMY OF SCIENCES AT BERLIN.

The following papers were read in this academy from the month of July to December, 1803:

July 7th. Observations on some points of the Grecian music, by M. Tremblay.

14th. An account of experiments on the alkaline matters contained in certain vegetables: a continuation, by the director Bernoulli.

21st. Observations on the logical regressus, according to the idea of the old commentators on Aristotle; and at the same time a short account of the life of M. Miloczewski, who made over to the academy a capital for the foundation of philosophical prize questions: by M. Nicolai.

August 4th. In the public sitting of this day, an oration by M. Merian, director. An eulogy on the minister of state, Baron Von Heynitz, by M. Gerhard. Anecdotes of the life of the princess Barbe, daughter of John the Alchymist, by M. Erman. An eulogy on M. Engel, by M. Nicolai. On Pestalozzi's method of teaching, by professor Fischer.

September 15th. A fifth dissertation on the painting of the antients, from its origin to the 94th Olympiad, or Apollodorus of Athens.

22d. An essay on a new theory of the existence and qualities of the physical elements, deduced from general experience, by Dr. Hermbstadt.

29th. New observations made at the observatory in the year 1802, together with the results; and several astronomical observations and remarks from his correspondents, by professor Bode.

October 6th. An eulogy on M. Anieres, by the director Merian.

15th. A fragment in regard to an essay on the history of the Alps, comprehending reflections on the language of the people who inhabit in particular the Pais de Vaud, by the Abbé Denina.

25th.

25th. Researches on the inflammable matter of particular fossils; on a green earth from New East Prussia; and a supplement to the history of meteoric stones, by Dr. R. Klaproth.

27th. A second memoir on the relation between music and declamation, by professor Burja.

Nov. 3d. On a new kind of logical algorithm, by professor Castillon.

10th. On Seneca's consolation to Polybius, by professor Spalding.

17th. On the plants of the species *chara*; and on the preservation of potatoes, by professor Willdenow.

24th. On the gauging of casks, by M. Eytelwein.

Dec. 1st. Continuation and conclusion of philosophical and moral thoughts, by M. Ancillon. Memoir of Baron de Chambrier on the expedition into Greece in 1368, and on the political system of Europe at that period, by M. Erman.

15th. Aërostatic experiments made at Hamburgh on July 18th by M. Robertson, by professor Tremblay.

22d. A third memoir on the methods of approximation, by the same.

ACADEMY OF SCIENCES AT COPENHAGEN.

In the sitting of the 3d of February, professor Bugge read a dissertation on the eclipse of the moon which took place on the 26th of January.

THE ACADEMY OF SCIENCES AT STOCKHOLM.

This academy, to preserve the remembrance of one of its oldest and most meritorious members, the late Von Ferrner, counsellor of the chancery, and as a mark of its gratitude for a considerable legacy bequeathed by him to it, has resolved to strike a medal representing on one side his bust, and on the other a laurel garland, having within it the words *Meriti tanti non immemor unquam:* below, the words *Socio munif. def.* 1802. *R. Ac. S. Stockh.*

IMPERIAL ACADEMY AT PETERSBURGH.

By an imperial ukase the members of this society have obtained permission from the emperor, after inspecting and approving drawings submitted to him, permission to wear the following uniform: a dark blue coat, with standing collar of red cloth; facings of the same, and blue lining; the collar and facings embroidered with gold. The other articles are of white cloth with yellow buttons. The use of this

this uniform is extended to the president, the academicians and adjuncts, and also to the pupils; but with this difference, that, besides on the collar and facings, they have embroidery on the pockets, which is not the case with the adjuncts. The pupils have the uniform without embroidery.

M. Gorachow, a merchant of Jakusk, has transmitted to his imperial majesty a horn of extraordinary size, which was found in the river Krom. This rarity has been sent to the academy of sciences, to be preserved in its museum. It is worthy of remark, that the inhabitants of the district where this horn was found believe it to be the claw of a bird called *Kogroskari*.

L. *Intelligence and Miscellaneous Articles.*

ANTIQUITIES.

Baron D'Aretin, librarian to the elector of Bavaria at Munich, has made a very curious discovery in the central library of that city: it is an old manuscript of the thirteenth century, containing a treatise on the Greek fire; which not only gives an account of the method of preparing it, supposed by the learned to be lost, but also a process for making gun-powder similar to that followed at present.

NEW VEGETABLE ACID.

M. Klaproth, in Scherer's Journal of Chemistry, has given a paper on the nature of a saline substance observed and collected in the botanical garden of Palermo, by Mr. Thomson, on the bark of the white mulberry tree (*Morus alba*).

This matter was of a brownish colour; it covered and even penetrated the bark. Its taste was nearly similar to that of the succinic acid. On coals it swelled up slightly and burned, leaving an earthy residuum. A thousand parts of water dissolved thirty-five parts of this salt warm, and fifteen cold. By evaporation it gave crystals in needles united in a radiated form, and of a pale woad colour.

Barytes formed no precipitate in the solution of this salt.

Alkaline carbonates occasioned in it a brown deposit, which by calcination passed to white, and then dissolved with effervescence in nitric acid. The sulphuric and oxalic acids occasioned in a nitric solution of it precipitates, which indicated the presence of lime.

Acetite

Acetite of lead formed in it an insoluble precipitate, reducible on burning coals.

Nitrate of silver, brown, brilliant, and light scales.

These experiments induced M. Klaproth to conclude that the salt collected on the bark of the mulberry tree was composed of lime and a particular vegetable acid.

On decomposing this salt by carbonate of ammonia, M. Klaproth obtained a deposit of carbonate of lime. The supernatant liquor gave, after proper evaporation, long narrow prisms; the water even of these crystals precipitated nitric solutions of copper, green; of cobalt, pale red; of uranium, yellow; of iron, brown; of mercury, silver, and lead, the same. It rendered slightly turbid a solution of acetite of barytes in water, muriates of tin and of gold, and nitrate of nickel: but these precipitations, according to the author, might be the effect rather of the extractive matter which adhered to the acid, than of a chemical combination with the metallic solutions.

To obtain the pure acid, M. Klaproth employed the precipitate obtained by a mixture of the solution of the calcareous salt and the acetite of lead. This precipitate was then decomposed by sulphuric acid diluted with water. The proportions employed were 24 grains of acid, diluted with one gros of water. The sulphate of lead was separated by the filter. The liquor, when evaporated, gave by crystallization 34 grains of acid in fine needles of a pale woad colour.

The natural calcareous salt was also decomposed directly by sulphuric acid. The result was the same. Thirty grains of salt, and twelve of sulphuric acid, were employed.

The properties of this new acid are: a very striking acid succinic taste; it remains in the air without experiencing any change; it dissolves easily in water and alcohol, and does not precipitate metallic solutions. When distilled, it appears only in part decomposed; a portion is destroyed, and the other is sublimated. This method may be employed to separate it from the extractive part, to which it adheres too strongly to be freed from it in the moist way.

M. Klaproth proposes to call this acid the *moronilic*, and its saline combinations *moronitates*.

TRADE AND COMMERCE.

A new periodical work has appeared at Petersburg under the title of the Petersburg Imperial Journal of Trade: it is published both in the Russian and German languages. The first number contains a view of the history of Petersburgh, in

in which the author gives the following account of the present state of that capital and of its trade:—The city contains 7124 houses, many of them of considerable size; and 209,000 inhabitants. The increase of its trade is remarkable. The amount of the exports was:

In the year	1742	-	2,479,656 roubles.
	1752	-	4,353,694
	1762	-	5,217,006
	1772	-	6,451,494
	1782	-	11,467,347
	1792	-	22,224,331
	1802	-	30,498,663

GALVANISM.

To Mr. Tilloch.

SIR,

Upon turning over the Transactions of the Academy of Sciences at Paris for the year 1700, I found the following article, which, as it throws some light upon the discovery of Galvanism, I hope you will think worthy of a place in your work. I am, &c.

G. H. BROWNE.

Westminster Fire-Office,
April 25, 1804.

"*Of the Trembling of the Nerves of a Frog after Death.*

"M. Du Verney showed a frog just dead, which, in taking the nerves of the belly of this animal which go to the thighs and legs, and irritating them a little with a scalpel, trembled, and suffered a sort of convulsion. Afterwards he cut these nerves in the belly, and holding them a little stretched with his hand, he made them do so again by the same motion of the scalpel. If the frog had been longer dead, this would not have happened: in all probability there yet remained some liquor in these nerves, the undulation of which caused the trembling of the parts where they corresponded; and consequently the nerves are only pipes, the effect whereof depends upon the liquor which they contain."

The above is the most remote instance we have seen adduced of effects to which we now apply the term Galvanic. Gardiner, in his Observations on the Animal Economy, maintains that there is in animals a vital principle, distributed in the brain, cerebellum, and medullary substance, of which principle the nerves are the conductors. Lughi

and Klagel conjectured that the electric fluid is determined by the nervous fluid secreted in the glands of the brain to the nerves themselves. Gardini relates an experiment made on lizards: he observes that, if one of these animals be decapitated and laid on glass, by bringing an electric substance into contact with the neck, and laying the finger on the tail, convulsions are produced. These authors were all anterior to the discovery of animal electricity.

HORNEMAN, THE TRAVELLER.

The Danish consul at Tripoli, M. Nissen, saw in September last, at the house of the pacha's minister, Ali Muhamed Dghies, a merchant of Fezzan, who had arrived with the caravan, and who had been at Buran. From this merchant he learned that Horneman, the celebrated traveller, who was known in that place under the name of Jussuf, had set out for Gondash in order to proceed to the coast for the purpose of returning to Europe.

NEW METAL EXTRACTED FROM PLATINA.

In a late sitting of the National Institute, Collet Descostils, engineer of mines, read a memoir, in which he announced the discovery of a new metal found in great abundance in the black dust left by platina when dissolved in the nitro-muriatic acid. The principal properties of this metal are: It gives a red colour to the triple salts of platina; with the triple ammoniacal salt of platina it is precipitated: it is easily reduced: it dissolves readily in acids, even the nitro-muriatic, when in the metallic state; the oxides are green or blue, or at least communicate these colours to the acids in which they are dissolved: these oxides seem to be volatile, &c. C. Descostils found also that the sand which accompanies platina contains titanium when susceptible of attraction by the magnet, and that when not so it contains chrome.

In the same sitting Fourcroy and Vauquelin presented a memoir also on this new metal. They stated, that having known that C. Descostils had made the discovery, they were unwilling to dispute with him that honour, and that they had waited till he should announce it before they published a large work they have composed on that subject.

ON EXTINGUISHING FIRES.

M. Driuzzi has invented a kind of liquor which in certain cases prevents combustion. A commission, appointed by

by the government of the Italian republic, has confirmed its efficacy, and it has been published by order of the minister of the interior. It consists merely of a solution of two parts, in weight, of pulverized common soda in seven parts of water, which is reduced to two-thirds by ebullition, and strained through a piece of cloth.

It is stated that this liquor produces no more effect on wood in a state of combustion than common water; that it would be dangerous in the inflammation of alcohol; but that it is exceedingly useful for extinguishing fires produced by oily, fat, and bituminous substances.

NEW PROCESS FOR PREPARING MILK OF SULPHUR*.

Heat to redness in a crucible eight parts sulphate of potash with one part of pounded charcoal. After gentle fusion, dissolve the mass in four times its weight of water, and, having boiled it, add sulphur until the liquor refuses to dissolve any more. Then dilute it with twenty parts of water, and leave it at rest: decant the liquor, and precipitate it by sulphuric acid diluted with water. The quantity of the product is equal to half the sulphate of potash employed. The sulphur might even be precipitated by distilled vinegar, to obtain the acetate of potash; but in this case it would be necessary to concentrate the vinegar by freezing, to avoid too great volume in the liquor.

AUGUSTINE EARTH.

In addition to the article on this substance, given in our last (p. 190), we subjoin the following extract from the *Journal de Physique*:

"The name of *beryl* was given to small hexaëdral crystals found in a kind of Saxon porphyry. Tromsdorff analysed this supposed beryl, and asserted that he obtained from it a new earth to which he gave the name of *augustine*; that is to say, without taste. Vauquelin has repeated the analysis of this substance, and found that it is phosphated lime, or a kind of apatite."

EXTIRPATION OF THE PLAGUE.

Professor Valli and Dr. Pezroni set out some time ago from Constantinople for Natolia, in order to make further experiments there, and in other parts of Asia, on the means of extirpating the plague.

* Published in Tromsdorff's Journal of Pharmacy, vol. ix. no 1.

METEOROLOGICAL TABLE*

For April 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	11 o'Clock, Night.	Noon.	Height of the Barom. Inches.	Weather.
1804. Mar. 27	41°	47°	38°	29·29	Fair
28	37	44	36	·54	Showery
29	35	51	44	·87	Fair
30	45	54	46	·62	Showery
31	40	48	35	·19	Rain, with snow and thunder
April 1	34	44	36	·36	Fair
2	33	45	36	·22	Hazy
3	37	46	37	·39	Fair
4	39	50	38	·60	Showery
5	38	43	37	·45	Showers of snow
6	37	51	39	30.10	Fair
7	38	53	37	·23	Fair
8	39	54	36	·24	Fair
9	37	47	40	·09	Fair
10	40	43	39	29·90	Cloudy
11	40	41	37	·91	Cloudy
12	37	43	38	·81	Cloudy
13	39	42	40	·74	Cloudy
14	41	52	44	·70	Fair
15	43	56	46	·62	Some showers of rain
16	43	49	44	·58	Cloudy, with a strong wind
17	40	46	40	·61	Cloudy, with ditto
18	41	47	35	·5	Fair
19	36	44	34	·78	Showers of hail
20	35	39	33	·62	Showers of snow
21	34	46	39	·58	Showers of snow
22	39	47	38	·65	Fair
23	39	44	47	·58	Rain
24	48	58	49	·65	Showery
25	51	57	48	·46	Showery
26	49	58	49	·55	Showery

* By Mr. Carey, of the Strand.

LI. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones.* *By* DAVID MUSHET, *Esq. of the Calder Iron-Works.*

[Continued from p. 201.]

IN order to ascertain whether there existed any affinity betwixt carbon and calcareous earth in high temperatures, amounting to a fusion of the latter, the following experiments were made with the four following substances, viz. calcareous spar, chalk, Kilkenny marble, and pure calcareous earth.

Before I begin this detail I think it proper to observe, that when no particular nature of crucible is mentioned, one of Sturbridge clay is always implied. The carbon used was formed from the burning of lamp-black, which was found to contain less ash than any other charcoal I had tried, and therefore less likely to injure the results by any premature degree of fusibility arising from such a mixture of ash. Its purity was further inferred from a superior affinity to iron, not only more instantaneous, but more extensive in its effects than either charcoal of wood or that made from animal substances. Oak forms frequently a very pure charcoal, containing not more than 1-150th part of its weight in ash. Lamp-black contains not more than 1-280th part; and its tendency to revive a given quantity of oxide of iron was found, upon the average of five experiments, to be to the former as 65 to 58.

The tops of the crucibles were accurately ground, and the covers made to fit nearly air-tight. The matter to be operated upon was introduced into the crucible while the latter was at a red or bright red heat, and the cover, in a similar state, simply put on, and both introduced into the furnace. This mode of operating is infinitely more accurate than luting, and using a green crucible: indeed, these experiments could never have been made within a 100dth part of the truth in that way. A quantity of the water, which is necessary to give softness and plasticity to clay, remains after drying, and ultimately evaporates as the heat to which the clay is exposed increases. If charcoal is presented to it in this state it disappears in great quantities, and renders any experiment as to quantity extremely doubtful.

Experiment I.

I took a very transparent crystal of double refracting spar and exposed it to a heat of 166° of Wedgewood. It was found fused into a very perfect glass of a rich green amber colour, considerably transparent.

Experiment II.

A fragment of the same crystal, weighing 20 grains, was introduced along with one grain of lamp carbon, and a perfect fusion was obtained. The charcoal had entirely disappeared, and the colour of the glass was changed to a deep fiery amber colour, less transparent than the result in Exp. I.

Experiment III.

The same spar, weighing 20 grains, was mixed with $1\frac{1}{2}$ grain of lamp carbon, and introduced into the furnace. The fusion was completed in fifteen minutes. I found a perfect glass of a cloudy milky lead colour. A minute portion of the charcoal remained, and there appeared twenty-three globules of iron upon the surface of the glass, many of which were so small as not to be visible by the naked eye; estimated at half a grain, or $2\frac{1}{2}$ per cent.

Experiment IV.

I took another crystal of the same double refracting spar, and distilled it in a gradually increasing heat for five hours. I found it had lost its transparency, but had preserved its figure and form in a most perfect manner. The original laminæ were entire, and alternated in various shades of colour, several of which seemed derived from iron.

The crystal at first weighed - -	69 grs.
After distillation - - -	39
Lost of water and carbonic acid, equal to 43·48 per cent. - - -	30

Twenty grains of calcareous matter thus obtained were fused *per se*, and a very fine portion of glass was the result. The colour was a watery blueish glass faintly marked with green, not very transparent.

Experiment V.

Double refracting spar deacified 20 grains, pounded and mixed with one grain of lamp carbon, was fused into a glass similar to No. III, but more inclined to a lead colour, and possessing less transparency. About 1-6th of a grain of carbon remained upon the surface of the glass, and the

number of globules of iron revived amounted to seventeen, and which I estimated to be equal to half a grain.

Experiment VI—*with Chalk.*

Fifty grains of white very well dried chalk was introduced *per se*, and fused in a heat of 165° of Wedgewood. A beautiful amber green coloured glass was obtained, possessed of great depth of transparency. When cold, the bottom of the crucible and the smallest speck were visible through the thickness of glass, which was more than a quarter of an inch in the middle. Compared with No. I, it possessed a darker tinge of green.

Experiment VII.

Raw chalk finely pounded	-	50 grs.
Lamp carbon 1-50th, or	-	1

There resulted from the fusion of this mixture a dark green primrose coloured glass, possessing some tints of the topaz. Its transparency was not in the least impaired by the union of the carbon, the whole of which had disappeared.

Experiment VIII.

Raw chalk pounded	-	-	50 grs.
Lamp carbon 1-20th, or		-	$2\frac{1}{2}$

I obtained from the fusion of this mixture, at a heat not exceeding 159° of Wedgewood, a very perfect glass of a dark fiery amber colour, possessed of a greater degree of lustre and effect than any of the former products. The charcoal had disappeared, and the surface of the glass remained free from any appearance of metal. Compared with No. II, the results seemed altogether similar. The present seemed, although the greatest mass, to have the advantage in point of transparency.

Experiment IX.

Raw chalk pounded	-	-	50 grs.
Lamp carbon 1-15th, or		-	4

A perfect fusion was here obtained, as in the former experiments. The glass possessed a dark blueish lead colour, transparent in their fragments, but dull and opaque in the mass. It exactly resembled the earthy parts of an iron ore when separated from their metallic contents by fusion in a black lead crucible, when the richest carburated iron is produced. There remained untaken up half a grain of charcoal, mixed with some particles of the calcareous earth of a pure white colour. The surface of the glass was nearly covered

 all

all over with silvery shining globules of iron, which I estimated to weigh nearly $1\frac{1}{2}$ grain, or 3 per cent.

Experiment X.

I took a piece of the same chalk, well dried, and roasted it in a moderate heat for five hours.

When raw it weighed	- -	395 grs.
After roasting it weighed	-	236
Lost of water and carbonic acid, equal to 40·25 per cent.	-	159

Sixty grains of this roasted chalk was fused in a heat of 166° of Wedgewood, and a very perfect dense glass obtained. It possessed all the transparency of No. VI, which was the same substance fused *per se* in a raw state, but in place of an amber green it approached more to the colour and lustre of the emerald. It differed from No. IV, wherein deacified spar was fused, very materially, most probably owing to a greater quantity of iron in mixture in the state of oxide.

Experiment XI.

Roasted chalk	- - -	50 grs.
Lamp carbon 1-50th, or	-	1

A very perfect glass was obtained of a lead blue greenish colour, most evidently of the same species of glass with No. III, V, and IX, though lighter and more transparent. The charcoal had disappeared: no metallic globules were visible, although the state and colour of the glass indicated immediate precipitation.

Experiment XII.

Roasted chalk	- - -	50 grs.
Lamp carbon 1-20th, or	-	$2\frac{1}{2}$

A very dense glass was obtained, which in point of colour was the same as No. III, V, and IX. A large grain of charcoal remained untaken up upon the surface of the glass. A number of globules of iron were revived, which I estimated at 2 or $2\frac{1}{2}$ grains, several of the largest of which were covered with carburet of iron.

Experiment XIII.

Roasted chalk	- - -	50 grs.
Lamp carbon 1-33d, or	-	$1\frac{1}{2}$

This mixture was productive of a very beautiful glass. The colour light lead blue, faintly marked with green, of the same class with No. III, V, IX, XI, and XII. There remained untaken up nearly 1-6th of a grain of charcoal.

A very

A very handsome spherule of iron, slightly marked with carburet, was obtained, which weighed 1½ grain, equal to 3 per cent. from roasted chalk, or 2 per cent. from the chalk in a raw state. This experiment, compared with No. XI, shows that 5-6ths of a grain of additional carbon was requisite to precipitate the iron in a metallic state from its dose of oxygen and lime; but compared with No. XII proves, that although part of the carbon remained untaken up, yet there still remained in the glass a portion of iron in the state of oxide; to disengage which a greater aggregate of affinity was necessary.

Experiment XIV—*Kilkenny Marble.*

Fifty grains of this carbonate was fused into a glass of a mixed greenish blue cloudy colour. The upper surface porous, or rather cellular, of a lighter greenish colour and more transparent than the mass. The want of uniformity in the colour of this glass induced me to repeat the experiment four times; three of which yielded similar glasses.

Experiment XV.

Kilkenny marble, raw	- -	50 grs.
Lamp carbon 1-50th	- -	1

The fusion of this mixture afforded a perfect glass, wherein the charcoal had totally disappeared. The colour of the glass was a darkish green amber, which in some particular lights exhibited some fiery tints of a ruby colour. It resembled No. VIII considerably, but did not possess the same depth of lustre and transparency. The surface exhibited no appearance of metal in a revived state, although it was presumable that a portion of iron existed in the glass, and which had been affected, in point of colours, by the combination of the present dose of carbon.

Experiment XVI.

Kilkenny marble, raw	- -	50 grs.
Lamp carbon 1-20th, or	-	2½

A glass resulted from the fusion of this mixture exactly similar to Experiments No. III, V, IX, XI, XII, and XIII. There were found upon its surface four globules of iron, which weighed a minute fraction more than a grain, or 2 per cent. Half a grain of charcoal remained untaken up, so that only two grains, or 4 per cent., were here absorbed; whereas raw chalk, Experiment No. IX, took up 3½ grains, or 3¼ per cent. more than the Kilkenny carbonate, probably from its containing a larger quantity of oxide of iron.

 Expe-

Experiment XVII.

I took a piece of Kilkenny marble which weighed	875 grs.
After proper distillation I found it to weigh -	528
Lost of carbonic acid, and probably a little water, equal to 39·65 per cent. - - -	347

The colour of the lime thus obtained was very superior in whiteness and apparent purity to that obtained from chalk. 50 grains of it fused *per se* yielded a beautiful transparent amber-coloured glass, free from any metallic appearance. When compared with No. X, which was the fusion of burnt chalk, it differed very materially. The emerald colour, so marked there, was replaced by a yellowish fiery tint approaching to the blaze of the Brasilian topaz: neither did it in the least resemble the glasses obtained with the refracting spar, No. I, II, and IV.

Experiment XVIII.

Kilkenny marble, roasted -	50 grs.
Lamp carbon 1-50th - -	1

A perfect glass was obtained by the fusion of this mixture of a lead colour, and similar to Experiments No. III, V, IX, XI, XII, XIII, and XVI. Of revived iron there was obtained $1\frac{3}{4}$ grain. A few flakes of carbon remained upon the surface of the glass, but so small in quantity that they could not soon be estimated. It would appear, therefore, that 1-50th only of carbon disappears with deacified Kilkenny carbonate; whereas with chalk, in the same state, 1-33d part of carbon was absorbed. Less iron is revived in the experiments made with the former than with the latter; which most probably will account for the difference of the quantity of carbon.

Experiment XIX—*with pure Lime.*

I dissolved chalk in distilled vinegar, from which it was precipitated by carbonate of ammonia. The precipitate was dried, and possessed a very fine blueish whitish colour. It was afterwards heated to redness to drive off the acid, by which its colour was a little tarnished.

Twenty grains of it was exposed in a heat of 170° of Wedgewood in a Cornwall clay crucible. When cold, and examined, I found it resolved into a very delicate transparent glass of a deep watery colour, slightly teinted with sea green. This experiment was again repeated with a heat of 158°, and a purer and more delicate glass obtained, though when held to the light a tinge of green was perceptible. I then apprehended that the acid had dissolved a portion of the iron contained

contained in the chalk, which had also been thrown down by the alkali. These glasses, compared with No. I, IV, VI, X, XIV, and XVII, wherein the substances formerly operated upon were fused *per se*, exhibited a decided superiority of purity and transparency.

Experiment XX—*Cornwall Clay Crucible.*

Pure lime	- - -	20 grs.
Lamp carbon 1-80th, or	-	$\frac{1}{4}$

There resulted from the fusion of this mixture an elegant primrose-coloured glass, of a different class as to depth of water, if I am allowed the expression, delicacy of colour, and real transparency, from any of the former.

Experiment XXI—*Cornwall Clay Crucible.*

Pure lime	- - -	20 grs.
Lamp carbon 1-40th, equal to		$\frac{1}{2}$

This mixture was fused into a fine yellow amber colour, still retaining a decided superiority as to transparency and lustre. It only differed from No. XX in the richness or extra depth of the shade, which was intimately blended with bright yellow and amber.

Experiment XXII—*Cornwall Clay Crucible.*

Pure lime	- - -	20 grs.
Lamp carbon	- -	1

A perfect glass was here also obtained, but all the fine shades and tints of the two former experiments were lost. The glass was of the same colour and class with Experiments No. III, V, IX, XI, XII, XIII, and XVI, only possessed of a greater degree of transparency. One-fourth of a grain of charcoal remained untaken up, and two very minute globules of iron of a silvery colour were visible. These I estimated to weigh about the fifteenth part of a grain, and infer that the precipitated lime now made use of contained about 1-300dth part its weight of iron. These experiments were twice carefully repeated, with similar results. Excepting once, in the experiment last noticed, the charcoal had entirely disappeared. This I attributed to the crucible remaining too long unopened after being taken from the furnace, or to some unseen pore or crack.

It would appear to result from the foregoing experiments, that the combination of carbon with calcareous earth is extremely small, if not altogether doubtful. In all the substances submitted to experiment a portion of iron was contained.

tained, which of itself may nearly account for the disappearance of the various proportions of carbon. The various proportions which each contain will account, in a great measure, for any dissimilarity of result which the glasses indicated. The fusion of the refracting spar, Experiment No. I, is productive of a glass similar to No. VI, in which chalk *per se* was reduced; but the fusion of the marble yielded a glass materially different from both (Exp. XIV), and more akin to the fusion *per se* of the pure lime, Experiment XIX. The two latter yielded less iron than the former; from which it was presumable that their high colours resulted from the extra quantity of iron united to the carbonates.

When the carbonates are fused with 1-20th part their weight of carbon, the results are thus recapitulated. Double refracting spar yields a deep fiery amber-coloured glass. Chalk a glass similar, but a shade or two less brilliant, both without any signs of revived iron; but with the same proportion of carbon the Kilkenny carbonate yielded a clouded lead-coloured glass, presented a portion of its carbon still unconsumed, and gave out four globules of iron. Experiments No. II, VIII, and XVI, the direct inference I would draw from this circumstance would be, that as the Kilkenny carbonate contained less iron than either of the other two substances, a smaller portion of carbon was sufficient to discharge the iron; and seeing that a variety of amber colours mixed with greens existed no longer than the iron remained in a state of oxide, I would also infer that these colours depended upon the state of oxygenation of the iron altered by the different doses of carbon, and not on any peculiar combination of carbon with the matter of lime. This is further deducible from the fact of the glasses always attaining to the same colour, and nearly to the same transparency, as soon as the whole of the iron is revived: beyond this the addition of carbon even prevents the fusion of the lime, as in Experiment No. IX, and by no means unites to it by cementation, which shall be proved hereafter. The proportions of iron revived in all the carbonates are in the ratio of the quantity of carbon necessarily added to discharge the same. Upon a fair mean of all the experiments made with the carbonates respectively, it appeared to me that the chalk contained nearly 3½ per cent., the refracting spar from 2½ to 3, and the Kilkenny marble about 1½ or 2 per cent. of iron. Hence we find, that in the former there disappeared 3½ grains of carbon, or 7 per cent.; in

in the second an equal quantity, less a portion that was found untaken up; and in the last two grains, or equal to 4 per cent. of carbon.

The general results with the deacified carbonates may be thus briefly summed up:—Calcined refracting spar *per se* gives a glass of a light blueish watery cast, somewhat allied to pure lime, Experiment IV; calcined chalk, a dark emerald green, Experiment X; and calcined marble affords a rich dark brown amber, Experiment XVII. The roasted chalk becomes completely saturated with 1-33d part the weight of the earth of carbon, minus about 1-6th of a grain; so that about 2⅔ds per cent. of carbon disappears. The refracting spar yields a result similar; but the disappearance of carbon with the Kilkenny roasted marble is only equal to 1-30th, or 2 per cent. When the lime was thus used in a caustic state, a greater proportion of iron was at the same time revived by all that would have been contained in a weight of lime equal to the measure of the carbonic acid dispelled. It would appear from this fact, that the extra doses of carbon necessary to produce the final change of colour and the disengagement of the iron, used in the experiments with the carbonates, were not dissipated by uniting to the iron contained in them respectively, seeing that in the experiments with the deacified compounds not above half the carbon was requisite to revive from 30 to 40 per cent. of more iron. This may be accounted for in two ways; either by supposing a quantity of moisture in the carbonates, which by evaporating at a high heat dissolves a portion of the carbon, and escapes with it; or by supposing that a peculiar affinity is exerted upon the carbon by the carbonic acid, and a portion of the former by that means fixed in the calcareous matter by fusion. One thing however is certain, that the fusion *per se* of caustic and carbonate lime of the same nature forms glasses of very opposite colours. (See Experiments No. I and IV, No. VI and X, and No. XIV and XVII.) As the only difference betwixt these states of lime arises from the presence or absence of the fixed air and what water they contain, it can only be attributed to them, unless we can suppose that a small portion of oxide of iron contained in the lime, not exceeding 3 per cent., can, by undergoing an attenuated process of roasting along with the calcining lime, occasion a change of colour by superoxygenation.

Finally, upon this head of experiment, it seems obvious that the colouring principle in these glasses, from whatever they are obtained, is iron. Their colour in general is green

and amber mixed. Carbon darkens these shades, and conveys at times some very fine tints of colour, approaching to the fire of the ruby or the mellowness of the topaz. An extra dose of carbon destroys the transparency, and throws a cloudiness over the fracture of a blue wavy cast, always attended by the elevation of minute globules of iron upon the surface of the glass.

There is now only one thing that occurs to me that can be urged against the foregoing conclusions. It appears, that in proportion as the carbonates are free from iron, their fusion *per se* affords glass proportionably transparent; and in the case of the pure lime the result was nearly as transparent as water. If therefore the deduction formerly drawn, that the disappearing carbon unites not with the lime, but with the iron, be correct, the glasses, after the whole of the metal is discharged, ought to approach the transparency and purity of the fusions *per se*. The reverse is however the fact; for in no stage of these experiments do the respective glasses exhibit a less degree of transparency than after the iron is discharged. I cannot decidedly account for this; but I am inclined to think that this permanent lead blue colour arises from a peculiar combination of iron with calcareous earth, experienced in a great many experiments with iron and steel.

[To be continued.]

LII. *Experiments on preparing Potatoes in Digesters for feeding lean and fattening other Stock. By the Rev.* William Pierrepont, *of Burton Park, Sussex.*

The thanks of the Society for the Encouragement of Arts, Manufactures, and Commerce, from the 21st volume of whose Transactions we copy the subjoined particulars, were voted to Mr. Pierrepont last session for the following communication:

"SIR,

"The object of the Society for the Encouragement of Arts, &c. being the general benefit of the community, I send you the following method of preparing potatoes, for the purpose of both feeding lean and fattening other stock; conceiving and hoping, from the experiments I have already made, that it will contribute something to the end which the society has in view. Not altogether satisfied with the system of curing or preparing potatoes by steam from heated water,

water, which I had practised, and conceiving that some better method might be found out, I made several experiments in the year 1801, and bestowed great attention and pains before I brought the following plan to bear.

"I have half a dozen common six-gallon iron digesters, which are filled with potatoes, either fresh washed from the water, or dry; for I cannot find that their being in a wet or dry state makes any difference. They are then put into an oven, the bottom of which is a cast iron plate, three feet ten inches long, by two feet ten inches wide; under which is the fire divided into three parts. Of this the middle part, or division, is eighteen inches: the two other divisions are ten inches each: the remaining eight inches rest upon the brick-work. The heat is conducted, half one way and half the other, round the sides of the oven to the mouth, which is nearly eighteen inches square, and then over the top, uniting in the chimney, in which is placed a damper. There is also an iron rod, with a segment of a circle at one end, for the purpose of pushing the digesters into the oven from the mouth, and a hook at the other end to draw them back to the mouth when done. The first round, that is, the six digesters first put into the oven take about two hours in baking, supposing the fire not kindled before they are put in; and every round after the first may be done in little more than an hour. This process requires very little fuel, and by no means the attention or the force necessary for steaming; as the potatoes will be done quicker or slower in proportion to the heat applied, without any of it being lost for want of greater force; even one round left in the oven over night, with a mere trifle of fuel, will be done the next morning: but I do not allow that to be done, because it turns the potatoes black, and hurts the digesters. Observe, the digesters must occasionally be rubbed on the inside with a little lard or dripping. Potatoes cured this way are not by any means so apt to turn sour, or scour the cattle, and are more dry; so that the animal fed with them drinks much more, and they become harder when cold, so as to be flung to the stock with more convenience than when steamed.

"In the year 1802 I fattened fifteen brace of bucks chiefly with them; I say chiefly, for after the potatoes were gone they had a few beans. They were very fine, and peculiarly well flavoured. Biggs, at Temple Bar, had thirteen brace of them. I also fattened, the same year, with them, two oxen, three cows, and two pigs, which were equally well flavoured,

flavoured, particularly the fat: the pigs had, towards the latter end, a few whole peas after each meal; the bucks had six pounds per day each, at an average; the lean deer in the park do very well with little more than a pound per day, instead of hay. This year, that is within the last seven or eight months, I have fattened two very large oxen and twenty Welch wethers; the wethers, with which there were two South-Down rams, and one ewe, had eighty pounds of the potatoes per day, with a little cut hay. The ewe was put with them to teach the other sheep to eat them: she has since had twin lambs; and the bailiff acknowledges that the lambs do better than the others at turnips, though he, with some other persons, dissuaded me from trying more ewes, under the idea that the potatoes would dry up their milk. Four dairy cows never did so well with very good hay, as they did last winter with about four pounds of the potatoes and about five pounds of rubbishy hay and straw cut. But enough on this head.

"The earl of Egremont had two of the Welch wethers, and a sirloin of beef from one of the oxen. The other, for sale, on the 22d of March, weighed 343 stone: he has had about forty pounds thrice a day. I take the liberty of referring to lord Egremont for the flavour of the meat. He has seen the process; and I shall request the honour of his lordship's transmitting this to you, in case he thinks it deserving the society's attention. I am, sir,

Your obedient servant,

Burton Park, near Petworth, April 28, 1803. W. PIERREPONT."

Charles Taylor, Esq.

"I know nothing of the expense of preparing potatoes in this manner, but I am inclined to think that they are more nutritious than in any other mode of dressing. I did not think it possible to bring such large oxen to such a state of fatness upon potatoes.

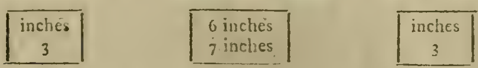
"EGREMONT."

"SIR,

"With all due acknowledgment to the Society of Arts, &c. for the honour they have done me, as communicated to me in your letter of the 27th instant, and which came to hand yesterday, I could wish the subjoined additions to be made to the account you already have. My reason for wishing it is, that any person willing to try the method in question may profit by the general result of the many and various

various experiments I made, without being at the expense and very great pains I was at, before I could bring it to bear in its present form. I had not the most distant idea of using digesters at the onset of the business; neither had I, nor have I, any interested motive in view, either for myself or any other person, or indeed any motive than the benefit the public might derive from it. I have deemed it necessary and proper, both out of respect to the earl of Egremont and myself, to make the above declaration and remark on this occasion. The following experiment was made, for the earl of Egremont, to ascertain the quantity of fuel, &c. as per date.

"At Burton Park, 21st of May 1803, three bushels of potatoes were weighed separately (each bushel weighing sixty pounds) before they were put into the six digesters. The potatoes from the two first digesters, taken out of the oven when baked, and weighed together, were fifty-five pounds; those from the two next were fifty-four pounds; and those from the third two were fifty-four pounds. The carpenter measured the wood with which they were baked; and he tells me, that a cord, or stack of good firewood well piled (that is, wood cut into three-feet lengths, and piled twenty-four feet in length and one foot ten inches in height, and which is sold in this neighbourhood for 12*s.*) will bake ninety sets, or ninety times six digesters full of potatoes, at the rate of wood it took to bake the above six, which was the second set that day. A cast iron plate, five feet in length, instead of three feet ten inches by two feet ten inches, will hold eight digesters, and by adding a small fire, thus,



on each side of the great fire-place, will, in my opinion, accelerate the baking from fifteen to twenty minutes in every set, as well as be some saving in fuel; because the side digesters generally take that time longer than the centre one. The merit of this process does not consist in slow simmering; for, the quicker the potatoes are done, provided proper attention is paid to them, the better. With the four following observations adhered to, any person may exercise his own judgment, and indulge his own information and fancy in erecting his oven, whether it be for a greater or smaller number of digesters, and according to the quantity of potatoes he may wish to bake.

"1st,

"1st, The digesters, or other vessels containing the potatoes, must not be in contact with the fire. 2d, The said vessels, even placed on cast iron, must have legs, so that the bottoms of them do not touch the cast iron. 3d, The lids must be steam-tight, in order to prevent its escaping before the potatoes are nearly done, with valves, if not the same, something similar to those of the digester. And, 4th, The external air is to be excluded from them; and the more effectually that is done, the better; both for saving fuel and time, as well as to prevent their burning. I have never had occasion for more than six bakings in a day; which six bakings, that is, six sacks or eighteen bushels, at sixty pounds the bushel, were done within twelve hours. The father and his son had 12*s.* per week for getting from the heap, washing and baking the potatoes, cleaving the wood for ditto, and feeding stock: 1080 lbs. of potatoes are baked for little more than six parts out of ninety of the cord, or stack of wood, above described. My opinion is, that two ovens of six or eight digesters each (according to the quantity of potatoes wanted) would answer the best purpose; particularly where coals would be used, or the wood is ready cut; for then the same person could attend both, and one would be baking whilst the other was emptying and filling, and this whether for a great or small quantity. Perhaps two ovens erected together, with a single brick laid flat to divide them, with two fires at the end, so that each flue would go the whole length of the plate, mounting at the other end, and so over the top into the chimney, and the two doors of them at the two fronts, would answer very well in point of œconomy, &c. Perhaps also an orifice just above the mouth of the oven, or in the door, with a moveable valve fixed to it, would prove useful, so that the steam which issues from the valves of the digesters about ten or fifteen minutes before the potatoes are done, and which smells like that from roasted potatoes, might escape by it, instead of by the mouth of the oven. The above steam is attended by a hissing noise, and a kind of boiling commotion in the digesters, which the person attending them will very plainly hear on opening the door a little. When he perceives that noise, &c. begins to intermit, the digesters must be taken out, or the potatoes will burn at the bottom, and that in proportion to the degree of heat under them. A very little observation will soon make a person acquainted with the proper time of drawing them. The Society for the Encouragement of Arts is at full liberty

to

to publish what they think may be useful from what I have written; for public advantage is my grand object, as well as it is theirs. I remain, sir,

Your most obedient servant,

W. PIERREPONT."

Burton Park,
June 30, 1803.

Charles Taylor, Esq.

LIII. *Description of an improved Eight-Day Clock, to strike without a Fly; invented by Mr.* EDWARD MASSEY, *of Hanley, in Staffordshire.*

THE Society for the Encouragement of Arts, &c. voted, last session, a bounty of twenty guineas to Mr. Massey for this invention; a model of which is reserved in the society's repository. The subjoined account of it is by Mr. Massey*.

"Having for a number of years considered a method of striking a clock at certain regular intervals, which I conceive may be of great service in making observations on the heavens, and ascertaining the velocity of sound, &c., I beg leave to lay before the Society for the Encouragement of Arts, &c. a striking part of an eight-day clock, which I have no doubt will answer the purpose intended; and if, upon examination, the Society should be of opinion that it may be useful, I trust they will reward it according to its merit. They will find that the work of this model is less than that of the common striking-movements, and may be made by a common workman, with less expense and trouble; the weight required is also considerably less. The principle I act upon is the pendulum, by which I regulate the stroke, instead of the fly; the advantage of which must be obvious to every one. The machine consists of a toothed wheel A, one pinion B, a pin wheel C, pallets DD, pendulum E, and locking detent G. The hammer-work F is as usual, and strikes on the bell at H. The weight hangs to the cord I. (See Plate VI. fig. 1 and 2, where a front and side view of the machinery are given, and where similar letters denote the same parts in each view.

"I consider it is only necessary for me to give the description of the wheels, so as to be a direction to a mechanic

* From the *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, vol. xxi.

chanic who wishes to manufacture clocks on this principle. The main wheel A, with seventy-eight teeth, is to act in a pinion of eight leaves B. The pin-wheel C should be large, so that the pins on which the pallets D and the locking G act, may be flung as far from the centre as possible; which pins may be eight or sixteen in number. If eight, the pendulum E should be about nine inches long, and it will vibrate twice betwixt each blow of the hammer; but if sixteen pins are put in the wheel, the pendulum must be about three inches long, and will make four vibrations betwixt each blow. The pins for drawing the hammer must be eight in number, and be fixed in a circle of about half the diameter of the aforesaid pins. The locking plate is on the main wheel. The stop is against the pins on which the pallets act, and may be discharged by a flirt-piece.

"As I have described the model, I beg leave to point out the method of striking a clock by the common pendulum, true seconds, without any additional pendulum or pallets for the striking part.

"Fix a cantrite wheel with sixty teeth on the same arbor with a swing wheel of thirty teeth. Now, suppose a striking-part to be made in the common way of making an eight-day clock, so far as the pallet pinion, leaving out the warning and fly pinions. A crank-piece must be fixed on the pallet pinion, which must come into contact with the cantrite wheel, which is fixed on the swing-wheel arbor. Then suppose the clock to be set a-going, and the rack discharged, the pallet pinion will make a revolution on every vibration of the pendulum, by which means a clock will strike seconds as true as a pendulum vibrates, which I hope will be considered as useful for the purposes I have described. I also beg leave to observe, that a great advantage arises in both the above machines from their not being liable to foul, as the stroke is given by the certain and regular vibration, instead of the uncertain motion of the fly. Its advantage likewise depends on the cleanness of the work; and church clocks will be much benefited from the decrease of weight."

LIV. *Ac-*

LIV. *Account of Improvements for diminishing Friction in Clocks. By Mr.* EDWARD MASSEY, *of Henley, in Staffordshire**.

HAVING for a considerable time considered a method of diminishing the friction in escapements of pendulum clocks, which I conceive may be of great service in making better time-keepers, by relieving the pendulum from obstructions occasioned by friction in the train of wheels, and on the acting part of the pallets, I beg leave to lay before the Society for the Encouragement of Arts, &c. two escapements, which I have no doubt will answer the purpose intended. The difficulties which I propose to diminish in clock escapements, by this invention, are as follow:—First, it is allowed, that when the pressure against the recoiling escapement is diminished, as it is liable to be, from increase of friction in the wheel-work, the vibrations of the pendulum will not be performed in so short an interval. This circumstance has the contrary effect on a dead beat; for, when the pressure against the locking is the greatest, the vibrations will occupy a longer interval of time; so that the vibrations of the pendulum are liable to be affected from two causes—from an increase of friction on the acting part of the pallets, and from an increase or variation of friction in the train of wheels. These are the objects which I have bestowed great pains and expense to remove.

I beg leave therefore to give a description of two models of my improved escapement, that accompany this letter. First, a swing wheel is made, in the usual way of making it for a dead beat, except that it is not necessary to make the teeth with fine points. The pallets, instead of being fixed on the verge in the usual way, are fixed on two light detents, one on each side of the swing wheel. The lockings are on the inclined planes of the pallets, which are pressed against the teeth of the swing wheel by remontoiring springs, which should be under the command of the weight or main spring, so that if an increase of friction should take place in the wheel-work, the vibrations of the pendulum will not be much affected so long as there remains a power to raise the inclined planes. A momentum is communi-

* From the *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, vol. xxi.—The society voted a bounty of fifty pounds to the inventor. Models are preserved in the society's repository.

 cated

cated to the pendulum through these inclined planes by two arms fixed on the verge, which come into contact with them, and unlock one on each vibration of the pendulum. Thus, suppose a momentum to have been given by the inclined plane on the right; at the same time that this takes place, the wheel moves forward and raises the inclined plane on the left, and the pendulum, having performed its oscillation to the left, receives a momentum from the inclined plane to compensate for the loss of power which would take place during the ensuing vibration to the right, and so on alternately. The advantage in this model consists, I conceive, in diminishing the friction in the acting part of the pallets, in giving a regular certain momentum, independent of any variation which may occur in the wheel-work, or on the acting part of the pallets, except during the short time of unlocking.

The second description, being a free pendulum without a verge, is as follows:—The swing wheel must be on the outside of the back plate. The pallets are formed like a pair of tongs, and are a fixture to the clock. There is a spring fixed in the upper part of the tongs, which keeps them extended against the points of the adjusting screws. The points of the tongs are pallets with inclined planes, and have lockings as the one above described. The tongs are made to spring from the point by which the pendulum is suspended, and, by altering the adjusting screws, a proper tension may be given to the spring part of the pallets; but they must be sufficiently under the influence of the main power. I think the main power should be about one-third more than is necessary to raise the inclined plane, so as to allow for an increase of friction which may take place in the wheel-work. There must be a cross-piece fixed to the pendulum, which must come into contact with two pins that are fixed in the inclined planes of the pallets, so as to unlock one on each vibration of the pendulum. Suppose the pendulum to be put in motion, and to have unlocked the inclined plane on the right; the wheel moves forward, and raises the inclined plane on the left, at which time the pendulum receives a momentum from the spring pallet on the right, and, after performing its excursion to the left, receives a momentum as on the right, and so on alternately. The advantage of this escapement over that above described is, that it avoids the friction of the verge and detent pivots, and during a part of the vibration the pendulum is disengaged, so that it is a free pendulum. I have no doubt that the

the society will judge of this invention with their usual liberality and candour.

First Method. (See Plate VII. Fig. 1.)

A, the swing wheel.

BC, the two pallets.

DD, the detents on which the two pallets B and C are fixed.

E, one of the remontoire springs on the left side; another, similar to this, is on the right side of the frame, but is not shown in the plate.

F, the verge.

G, the arms fixed on the verge, which act on the pins HI of the pallets.

K, The pendulum, fixed in the usual way on the verge.

Second Method. (See Fig. 2.)

a, the free pendulum, without a verge.

b, the swing wheel on the outside of the back plate.

c,*d*, the pallets, formed like a pair of tongs.

e, a spring which keeps them extended against the points of the adjusting screws.

f, *g*, the points of the pallets.

h,*i*, the adjusting screws of the pallets.

k, The cross-piece fixed to the pendulum, which piece, as the pendulum moves backwards and forwards, comes in contact with the two pins on the points of the pallets *fg*, and relieves the wheel.

The pendulum is supposed to be in motion, and the dotted lines show those parts of the machine which are hid by others.

LV. *Observations on the Condition of the Inhabitants of the Cape of Good Hope.*

[Concluded from p. 187.]

3. The corn boors live chiefly in the Cape district, and those parts of Stellenbosch and Drakenstein that are not distant more than two or three days' journey from the Cape. Their farms are, some freehold property, some gratuity land, but most of them loan farms. Many of these people are in good circumstances, and are considered in rank next to the wine boor. The quantity of corn they bring to market

market is from a hundred to a thousand muids each, according to the quality of their farm, but more commonly to their skill and industry. They supply also the wine boor and the grazier. The grain sold to these in the country is subject to no tax nor tythe; but a duty, amounting not quite to one-tenth of the value, is paid at the barrier for all grain passing towards Cape Town. Their parochial assessments are the same as those of the wine boor.

The colonists of the Cape are miserable agriculturists, and may be said to owe their crops more to the native goodness of the soil and favourable climate, than to any exertions of skill or industry. Their plough is an unwieldy machine drawn by fourteen or sixteen oxen, just skims the surface, and, if the soil happens to be a little stiff, is as frequently out of the ground as in it; hence in most of their corn fields may be observed large patches of ten, fifteen, or twenty square yards without a stem of grain upon them. Such grounds, when sown and harrowed, are infinitely more rough than the roughest lea ploughing in England. They have not the least idea of rolling the sandy soils, which are sometimes so light as to be sown without ploughing. Sometimes, towards the end of the rainy season, they turn the ground and let it lie fallow till the next seed-time; but they rarely give themselves the trouble of manuring, except for barley.

For returns of corn in general they reckon upon fifteen fold; in choice places from twenty to thirty, and even much greater where they have the command of water. The grain is not thrashed, but trodden out in circular floors by cattle. The chaff and short straw of barley is preserved as fodder for their horses, and for sale; the rest of the straw is scattered about by the winds. They do not even give themselves the trouble of throwing it into the folds where their cattle are pent up by night, which would be the means of procuring them a very considerable supply of manure, and at the same time be of service to their cattle in cold winter nights.

The following rough statement will serve to show the circumstances of an ordinary corn boor of the Cape:

Outgoings.

The price of the opstal or buildings on his loan farm - -	R. D. 7000
50 Oxen *a* 15 Rd. - -	750
Carried over	7750

Brought

Brought over	R.D. 7750			
50 Cows *a* 8 Rd.	400			
12 Horses *a* 40 Rd.	480			
6 Slaves at 300 Rd.	1800			
2 Waggons	800			
Furniture	1000			
Implements of husbandry	500			
	12,730	Interest	763	6
Clothing for slaves			90	0
Ditto for the family			150	0
Tea and sugar			100	0
Duty on corn brought to market 150: parish taxes 20			170	0
Contingencies, wear and tear, &c.			150	0
Corn sold to the wine boors and graziers more than sufficient to defray all other expenses				
		Amount of outgoings	1423	6

Returns.

300 Muids of corn *a* 4 Rd.	R.D. 1200		
100 Ditto of barley *a* 3 Rd.	300		
6 Loads of chaff *a* 32 Rd.	192		
1000 lbs. butter *a* 40 $1\frac{1}{2}$ Sk.	250		
5 Horses sold annually *a* 40 Rd.	200		
	Amount of returns	2142	0
	Balance in favour of the farmer R.D.	718	2
	or £.	143	13

4. The graziers, properly so called, are those of Graaf Reynet and other distant parts of the colony. These are a class of men of all the rest the least advanced in civilization. Many of them towards the borders of the settlement are perfect nomades, wander about from place to place without any fixed habitation, and live in straw huts similar to those of the Hottentots. Those who are fixed to one or two places are little better with regard to the hovels in which they live. These have seldom more than two apartments, and frequently only one, in which the parents, with six or eight children and the house Hottentots, all sleep; their bedding consists generally of skins. Their hovels are variously constructed, sometimes the walls being mud or clay baked

baked in the sun, sometimes sods and poles, and frequently a sort of wattling plastered over with a mixture of earth and cow-dung, both within and without; and they are rudely covered with a thatch of reeds that is rarely water-proof.

Their clothing is very slight; the men wear generally a broad brimmed hat, a blue shirt, and leather pantaloons, no stockings, but a pair of dried skin shoes. The women have a thick quilted cap that ties with two broad flaps under the chin, and falls behind across the shoulders; and this is constantly worn in the hottest weather; a short jacket and a petticoat, no stockings, and frequently without shoes. The bed for the master and mistress of the family is an oblong frame of wood, supported on four feet, and reticulated with thongs of a bullock's hide, so as to support a kind of mattress made of skins sewed together, and sometimes stuffed with wool. In winter they use woollen blankets. If they have a table it is generally of the boor's own making, but very often the large chest that is fitted across the end of their ox waggon serves for this purpose. The bottoms of their chairs or stools are net-work of leather thongs. A large iron pot serves both to boil and to broil their meat. They use no linen for the table; no knives, forks, nor spoons. The boor carries in the pocket of his leather breeches a large knife, with which he carves for the rest of the family, and which stands him in as many and various services as the little dagger of Hudibras.

Their huts and their persons are equally dirty, and their whole appearance betrays an indolence of body and a low grovelling mind. Their most urgent wants are satisfied in the easiest possible manner; and for this end they employ means nearly as gross as the original natives, whom they affect so much to despise. If necessity did not sometimes set the invention to work, the Cape boor would feel no spur to assist himself in any thing; if the surface of the country was not covered with sharp pebbles, he would not even make for himself his skin shoes. The women, as invariably happens in societies that are little advanced in civilization, are much greater drudges than the men, yet are far from being industrious; they make soap and candles, the former to send to Cape Town in exchange for tea and sugar, and the latter for home consumption. But all the little trifling things that a state of refinement so sensibly feels the want of, are readily dispensed with by the Cape boor. Thongs cut from skins serve, on all occasions, as a succedaneum for rope; and the tendons of wild animals, divided into

into fibres, are a substitute for thread. When I wanted ink, equal quantities of brown sugar and soot, moistened with a little water, were brought to me; and soot was substituted for a wafer.

To add to the uncleanliness of their huts, the folds or *kraals* in which their cattle remain at nights are immediately fronting the door, and, except in the Sneuwberg, where the total want of wood obliges them to burn dung cut out like peat, these kraals are never on any occasion cleaned out; so that in old established places they form mounds from ten to twenty feet high. The lambing season commences before the rains finish; and it sometimes happens that half a dozen or more of these little creatures, that have been lambed over night, are found smothered in the wet dung. The same thing happens to the young calves; yet so indolent and helpless is the boor, that rather than yoke his team to his waggon and go to a little distance for wood to build a shed, he sees his stock destroyed from day to day and from year to year, without applying the remedy which common sense so clearly points out, and which requires neither much expense nor great exertions to accomplish.

If the Arcadian shepherds, who were certainly not so rich, were as uncomfortable in their cottages as the Cape boors, their poets must have been woefully led astray by the muse. But Pegasus was always fond of playing his gambols in the flowery regions of fancy. Without a fiction, the people of the Cape consider Graaf Reynet as the Arcadia of the colony.

Few of the distant boors have more than one slave, and many none; but the number of Hottentots amounts, on an average, in Graaf Reynet, to thirteen to each family. The inhumanity with which they treat this nation I have already had occasion to notice*. The boor has few good traits in his

* In the second chapter of this work I have given an account of fifteen innocent Hottentots that were inhumanly butchered by the boors. A pamphlet has just been put into my hands which was published in the Cape by baron de P., private secretary to the governor, and in which the same fact is noticed in the following words: —" A Hottentot captain, of the name of Kouwinnoub, bearing the distinguishing mark of his rank (a stick, on the brass head of which were engraven the arms of his majesty), and furnished moreover with a passport signed by one of the members of government, went, accompanied by fifteen Hottentots, to procure a few leaves of tobacco in the plains of Sneuwberg. The boors, recollecting, perhaps, that three years ago these faithful soldiers had served the government by keeping them in order, thought it a favourable opportunity

character, but this is the worst. Not satisfied with defrauding them of the little earnings of their industry, and inflicting the most cruel and brutal punishments for every trifling fault, they have a constant practice of retaining the wife and children and turning adrift the husband; thus dissolving the tender ties of social intercourse, and cutting off even

tunity to revenge themselves on these unhappy creatures. Led on by a veld cornet of the name of Burgers, they seized the whole company, who suspected no ill; and, notwithstanding all the proofs in their favour, it was agreed that they were criminals, and that they must be treated accordingly. The boorish court of justice resolved, therefore, to bind them to a tree, and to draw from them by torture a confession of crimes of which a thought had never entered into their heads; to reiterated blows and inhuman tortures they held out promises of forgiveness if they would confess all that was required of them; and by these means they forced from them the unfortunate declaration that they came with an intention to plunder the neighbourhood. The only concern of the court was, to write down a confession, which the application of the torture, and the hope of being set at liberty, had wrung from these innocent victims. The boors put their names to this declaration as an attestation of the truth, and made an end of the business by voting for their death. The sentence was instantly put in execution, and the poor Hottentots were shot.—A whole half year has passed away since this event, and justice hitherto has not interfered, I should not dare to say wherefore."

I shall extract another instance of the savage brutality of an African boor, recorded in this pamphlet, which, if possible, exceeds all that have yet been given:—"As soon as the English had abandoned the fort (at Algoa Bay), a boor named Ferreira, of a Portuguese family, made himself master of it, and kept possession till the arrival of a detachment of troops, which government sent thither under the command of major von Gilten, who is still there. The Kaffers, fully persuaded that the late peace had put an end to all disturbances between them, sent to the new commander of the fort a bullock to be slain, as the test of reconciliation and friendship. The Kaffer sent on the occasion put himself under the guide of a Hottentot; and Ferreira, by way of returning the kind intention, laid hold of the Kaffer and broiled him alive; bound the poor Hottentot to a tree, cut a piece of flesh out of his thigh, made him eat it raw, and then released him!"

If any one should be disposed to think that I have exaggerated the cruelties committed by these inhuman brutes, I only request of them to read the pamphlet written by the private secretary to the present governor Jansens.

Nothing can be more deplorable than the state of the colony as described in this pamphlet, which was written just before they had heard of the war; and nothing can exceed the disappointment of the Dutch in their expectations with regard to the Cape. The Hottentot corps was disbanded; most of them fled into the interior to join their oppressed countrymen; the Kaffers were in arms against the boors; the garrison in a state of complete insubordination; the people detesting the government, and the government afraid of the troops; its credit destroyed, money disappeared, commerce ruined, bankruptcies without end; and they wanted only a war to complete their misery. Under such circumstances, how cheaply might England regain possession of this important settlement!

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the natural resources of wretchedness and sorrow. It is in vain for the Hottentot to complain. To whom, indeed, should he complain? The landrost is a mere cypher, and must either enter into all the views of the boors, or lead a most uncomfortable life. The last, who was a very honest man, and anxious to fulfil the duties of his office, was turned out of his district, and afterwards threatened to be put to death by these unprincipled people, because he would not give them his permission to make war upon the Kaffers; and because he heard the complaints of the injured Hottentots. The boor, indeed, is above all law. At the distance of five or six hundred miles from the seat of government he knows he is not to be compelled to do what is right, nor prohibited from putting in practice what is wrong. To be debarred from visiting the Cape is no punishment to him. His wants, as we have seen, are very few, nor is he nice in his choice of substitutes for those which he cannot conveniently obtain. Perhaps the only indispensable articles are gunpowder and lead. Without these a boor would not live one moment alone; and with these he knows himself more than a match for the native Hottentots and for beasts of prey.

The produce of the grazier is subject to no colonial tax whatsoever. The butcher sends his servants round the country to collect sheep and cattle, and gives the boors notes upon his master, which are paid on their coming to the Cape. They are subject only to a small parochial assessment, proportioned to their stock. For every hundred sheep he pays a florin, or sixteen-pence, and for every ox or cow one penny. With the utmost difficulty government has been able to collect about two-thirds annually of the rent of their loan farms, which is only 24 rix dollars a year. Under the idea that they had been dreadfully oppressed by the Dutch government, and that their poverty was the sole cause of their running in arrears with their rent, the British government forgave the district of Graaf Reynet the sum of 200,000 rix dollars, the amount to which their arrears had accumulated. By descending a little closer to particulars we shall be able to form a better judgment of the condition of these people, and how far their poverty entitled them to the above-mentioned indulgence.

The district of Graaf Reynet, as we have already observed, contains about 700 families. Among these are distributed, according to the *opgaaff* (and they would not give in more than they had, being liable to an assessment according to the number), 118,306 head of cattle, and 782,274 sheep,

which.

which, to each family, will be about 170 heads of cattle and 1115 sheep.

Out of this stock each boor can yearly dispose of from 15 to 20 head of cattle, and from 200 to 250 sheep, and, at the same time, keep up an increasing stock. The butcher purchases them on the spot at the rate of 10 to 20 rix dollars a-head for the cattle, and from 2 to 2½ for the sheep.

Suppose then each farmer to sell annually

15 Head of cattle *a* 12 Rd. -	R.D. 180	
220 Sheep *a* 2 Rd. - - -	440	
A waggon load of butter and soap 1200 pounds *a* 1*s*. - - -	300	
Amount of his income		R.D 920 0

Outgoings.

2 Waggons 800 Rd. interest -	R.D. 48	
Clothing for 8 persons *a* 15 Rd. -	120	
Tea, sugar, tobacco, brandy - -	150	
Powder and shot - - -	20	
Rent to government and stamp -	25	
Parochial assessments - -	8	
Contingencies, cattle to Hottentots, &c.	80	
Amount of outgoings		R.D. 451 0
Yearly savings		R.D. 469 0
		or £. 93 16 0

In what part of the world can even a respectable peasant do this? much less the commonest of all mankind, for such are the generality of the Cape boors. After quitting the ranks, or running away from his ship, he gets into a boor's family and marries. He begins the world with nothing, the usual practice being that of the wife's friends giving him a certain number of cattle and sheep to manage, half the yearly produce of which he is to restore to the owner as interest for the capital placed in his hands. He has most of the necessaries of life, except clothing, within himself; his work is done by Hottentots, which cost him nothing but meat, tobacco, and skins for their clothing. His house and his furniture, such as they are, he makes himself; and he has no occasion for implements of husbandry. The first luxury he purchases is a waggon, which, indeed, the wandering life he usually leads at setting out in the world, makes

makes as necessary as a hut, and frequently serves all the purposes of one. A musket, and a small quantity of powder and lead, will procure him as much game as his whole family can consume. The *spring boks* are so plentiful on the borders of the colony, and so easily got at, that a farmer sends out his Hottentot to kill a couple of these deer with as much certainty as if he sent him among his flock of sheep. In a word, an African peasant of the lowest condition never knows want; and if he does not rise into affluence, the fault must be entirely his own.

LVI. *Memorial of Mr.* E. G. J. Crookeens *respecting the Distillation of Spirits, &c. in Holland.*

[Concluded from p. 113.]

The water which is made use of is also deserving the utmost attention. Hard water, and which is loaded with many particles, produces less spirit, and of a harsh and hard quality. In Holland they make use of the water of the Meuse, and keep vessels expressly for that purpose, which load the water in that river, and convey it to the laboratory of the distillers. In other places, they take the water of small brooks, where the water flows over a sandy ground, and they take care to make a provision of it when the weather is still and calm, and not immediately after a heavy fall of rain, by which the water might have been muddy. They who have adopted the first method are of opinion, that by this operation, and by distilling the whole mass at once, they obtain a greater quantity of spirit, and that they have less trouble in making the composition. In this they are, however, grossly mistaken. The great many experiments I have made in Holland with either method, and which two years ago I repeated in the electorate of Hanover, at a distiller's of my acquaintance, have confirmed me in the opinion, that by this method no greater quantity is obtained, and that the spirit, *ceteris paribus*, is less pleasant and of a harsher taste, for this evident reason, that with the greatest precaution it is hardly possible to prevent the thick mass, exposed to the immediate action of the fire, from communicating to the liquor an empyreumatic taste; and it is by no means improbable, that previously to the fermentation, all the essential oil not having been set at liberty, a part of it has remained united and incorporated with the flour, or at least with the husks of the grain, and only disengages itself by the aid of the heat during

during the fermentation and distillation; so that, following this method, you are in danger of causing a large quantity of essential oil to go over with the spirit. This method has also the inconvenience attending it, that you are obliged to leave the caldron open till the liquid begins to boil, and that in the mean time a man must continually stir this mass with a stick to prevent it from sticking to the bottom of the caldron, and being burnt, until the liquor begins to boil up: at this time the greatest danger is over, and the lid is put on. Thus nothing is gained in point of trouble, because, in following the other method, you proceed immediately to the distillation. Among the advantages which the dilution of the mash, together with the slow fermentation and distillation, communicates to the spirit distilled in Holland, both in point of flavour and salubrity, must also be counted, that the best distillers know how to extract from this mash all the ferment, by which means the spirit is rendered more pure; because the ferment, of whatever nature it may be, contains most of the essential oil of the matter whence it is taken, and that by this method the greatest part of this oil is taken from the liquor before the distillation, while at the same time they derive from it this profit, that they never have occasion to buy their ferment from the brewers, but on the contrary sell, themselves, a considerable quantity of it, after having dried the same in the shape of loaves, in which state they preserve it for years, if it be kept in dry places; and in this state it is much sought after by bakers as well as by private families, because this dry ferment, which is diluted with a little water, never communicates to the bread or pastry the bitter taste which barm does, loaded as it is with the bitter particles of the hops. The distillers, who are acquainted with this method, enjoy the additional advantage, that they can continue to distil during the summer, and at such times when barm or yeast is extremely scarce. The profit which they obtain from this ferment is one of the reasons of the low price of the Dutch geneva, compared with the price of spirits distilled in other countries; but as they who are perfectly initiated in this art keep it a secret, I shall not explain at present the manner in which they proceed, from the motives which I have assigned at the beginning.

And as the Dutch distillers are under no sort of constraint in their operations, nor have the least reason to hurry them, they take the greatest care to clean after each operation their caldron, and above all their tubs, in which the vinous fermentation is effected; and they never fill them again,

again, but after having thoroughly cleared them from the ferment, which sticks to the sides of the tubs from the last fermentation, because they know from experience, that the least remains of this matter gives the following liquor a bad taste; for this purpose they clean them with lime water, and never with soap, because the caustic alkali contained in the soap would not fail to give the liquor an urinous taste.

By all these precautions they obtain a pure spirit, without being obliged to employ any noxious articles in order to destroy the bad and offensive taste, and at the same time a wholesome spirit. One circumstance, which contributes much to its salubrity, is this, that it is rectified over juniper berries, which possess a balsamic and aromatic virtue. It is at least averred by the most celebrated physicians both of Holland and other countries, that the juniper berries possess great medicinal virtue, for which reason aqueous decoctions of juniper berries are so frequently prescribed by physicians of acknowledged celebrity in inveterate rheumatims, which, after having baffled all other remedies, are commonly cured by a continued use of these decoctions; and if the juniper berries actually possess this virtue, who can then call in question the great benefits which the spirit, rectified over juniper berries, must afford the inhabitants of a cold and humid country, where the temperature of the air is so unsettled, that in the course of one day you experience several changes of heat and cold, and where, for this reason, rheumatic complaints cannot but be very common? I have experienced very generally that turpentine is substituted for juniper berries in the malt spirits distilled in this country in imitation of Duch geneva. It remains with physicians to decide, whether turpentine in this state, and taken in such quantities, must not prove highly detrimental to health. I, for my part, am at a loss to conceive that an article as resinous as turpentine (the residue of which, after the distillation, is colophonium) should not be highly prejudicial to health; and I am apt to think, that for this reason it would be certainly worth while for parliament to prohibit the use of turpentine, and enact that juniper berries be substituted in its place*; the more so, as the substitution of turpentine for the purpose of imitating the flavour of juniper berries, merely arises from the avarice of the distillers, and as Hol-

* The author, perhaps from erroneous information, supposes that distillers make use of what is commonly known by the name of turpentine; but it is the essential oil that is made use of, which contains no resin.—EDIT.

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land affords a striking proof and example, that if the use of juniper berries be not absolutely beneficial, it cannot at least be hurtful.

As the Dutch distillers are thoroughly convinced that the success of their operations depends on a slow distillation, they take particular care to have their fire-places constructed in such a manner, that the distiller may have it entirely in his power to abate or accelerate the action of the fire at every moment when he shall think it necessary. It is impossible to fix upon a peculiar form to serve in all cases, as it must naturally vary according to the form of the vessel; but they never lose sight of the following general rules: viz. 1st, That the place which contains the fire must be contrived in such a manner, that the action of the fire operates equally on the whole surface of the bottom of the caldron without being concentrated to one point, where the caldron would be burnt, and unavoidably and immediately communicate to the liquor an empyreumatic taste: by this equal action of the fire, the liquor is heated in a more equal manner, and by a moderate fire; and also quicker than if the fire acted only upon one point. 2dly, That the openings of the fire-places be iron doors, in which are made several small holes, which can be opened and shut, as occasion may be, to accelerate or check the current of air. 3dly, That the chimney be furnished with an iron plate, or damper, placed horizontally, by which the diameter of the chimney can be diminished as often and as much as the distiller chooses, who by this means moderates at pleasure the action of the fire, and can even stifle it at once, by shutting the openings in the fire-place, and the passage of the smoke into the chimney.

As the vinous fermentation is a point no less important, and one of the principal requisites on which depends the success of the operation, and as this fermentation can only be conducted slowly in a moderate temperature, they take great care that the laboratories, in which the vinous fermentation is effected, be constructed on such principles that the rays of the sun can be prevented from acting upon the tubs containing the liquor subjected to fermentation, by means of windows with shutters made every where opposite to each other, that in extraordinary hot weather a current of fresh air may be obtained to cool the laboratory. The floor is paved with stones, on which from time to time fresh water can be poured, which cools considerably the temperature of the atmosphere in the laboratory; and in winter it can be warmed by means of one or more iron stoves,

stoves, or, which is perhaps still better, a delft stove, which is made use of in several places in Germany, which are of a more equal, more moderate, and less stifling heat.

It must not be supposed that the distillers in Holland make use of a small quantity of malt, from a persuasion that no geneva can be obtained from the flour of rye, or any other grain, without that addition; the contrary is the truth: I have made several experiments with rye, without the least addition of malt; and I have always obtained the same quantity of spirit, but it was never of so pleasant a taste. This addition is only necessary inasmuch as it assists the fermentation; and that if it be used there is no occasion for so much ferment, and of consequence not so much essential oil is introduced into the liquor, which is the reason that the spirit is of a more pleasant flavour, and not so harsh as that which is made of rye, or any other flour. I must add in this place, that the Dutch distillers are extremely careful to make use only of such rye as is grown on a calcareous or sandy soil, and never employ, if they can possibly avoid it, any corn produced by a fat, clayey ground; and this is the reason why they make use of rye imported from Prussia, grown on a poor soil, and which, according to common report, is dried in kilns before it is exported, and on this account is known in Holland by the name of dried rye; the grain is small, and very hard and dry; because this rye produces more spirit and of a superior quality to that which is drawn from rye grown on a clayey soil, and because it contains less oily particles.

On comparing the process of the Dutch distillers with that followed in this country, it will be obvious, at first view, why the spirit, which is distilled, does not possess the perfection of Dutch geneva, either in regard to the flavour or salubrity; and all the questions to be proposed on this subject may be easily answered, from a mature consideration of the difference of these processes; and the prejudice entertained by many persons in this country as well as in Germany, that no spirit of the same quality can be produced in any other country, deserves only to be laughed at. These persons do not consider that geneva is a product of art, which neither depends on the soil nor on the climate of a country, as wine does, and that if you employ the same materials, and observe the same process, the result must necessarily be the same; nor is it less evident, that as long as the distillation shall be effected on the principles hitherto observed in England, the perfection of Dutch geneva can here never be obtained. In order to obtain it, government must

must necessarily cooperate, by giving the distillers full liberty to act and proceed according to their knowledge and experience; and I may hazard, without the least danger, the assertion, that as long as the duty is laid either on the quantity of the wash, or on the capacity of the still, the above can never be attained, and the distillers to avoid their ruin will be obliged to have recourse to pernicious ingredients. In the former case, their interest prompts them to overload their liquids with too great a quantity of grain, which not only causes them to sustain a considerable loss of spirit, because the water, which acts as a solvent to saccharine matter, can only dissolve and keep in a state of solution a certain quantity of that matter; but after it is saturated, the rest of that matter is lost. It further results from thence, that the fermentation, on which the success of the operation chiefly depends, proceeds not as regularly as in regard to a well diluted wash; and on distilling this thick and as it were over-saturated wash, the distiller introduces into his caldron a great quantity of oleaginous particles, and of consequence into his spirit more essential oil, especially if the distillation be pushed on with vivacity; besides that this thick wash, from the rapidity of the distillation, is likely to communicate to the spirit an empyreumatic taste, which would obstruct its sale if the rectifier did not correct this fault by noxious additions.

In the latter case, the interest of the distiller demands that he must conduct the distillation rapidly, and with a violent fire; the result of which is, that all the essential oil rises with the spirit, and that it also must contract an empyreumatic taste. It further results from this rapid mode of working, that the distiller does not allow himself sufficient time entirely to empty his caldron, or to clean it carefully, as well as the other utensils; which in my judgment must have a strong influence on the salubrity of the spirit on account of the verdigris, which, from want of cleanness, forms itself in the caldron and worm, if they are made of copper; and as the distillations succeed each other in so rapid a manner, the distiller cannot allow the liquor sufficient time to ferment slowly; he must therefore make use of more ferment, which cannot but produce a bad effect, both in regard to flavour and salubrity. They who assert that a rapid distillation has no influence upon the taste and flavour of the spirit, either try to deceive, or are ignorant of the first principles of the art of distillation; and in order to confound them, we have only to ask this question, Why are we obliged to distil fine and delicate liquors in *balneo mariæ*

mariæ (a bath of water) to give them that fine flavour which causes them to be so much esteemed? The answer is, Because, in this case, the action of the fire is not immediately directed against the vessel which contains the liquor, and because the heat is equal and uniform, and cannot be increased by the vivacity of the fire, because water which is in a state of ebullition cannot assume a higher degree of heat, and thus the liquors cannot contract any empyreumatic taste. If the fire had not any influence upon the spirit, these precautions would certainly be fruitless.

Persons who are of opinion that a rapid distillation has no influence upon the salubrity of the spirit, are equally mistaken. No one endowed with common sense, and possessed of the least knowledge of the art of distillation, can call it in question, that by a violent fire all the essential oil must be made to rise with the spirit, and the fiery and indigestible qualities of this oil, so copiously mixed with this spirit, are too well known to admit of the least doubt. They not only possess the property of intoxicating quickly, and causing head-ache, but also affect so very strongly the nervous system, as to cause a trembling when taken in any excessive degree; and in general it may be fairly asserted, that adulterated spirits possess the quality, in common with bad wine, of causing head-ache and trembling when drunk in an extravagant manner; which is not the case after an excess committed in drinking good and pure wine: and I rather incline to think, that by this rapid distillation some particles of copper are disengaged, and rise and mix with the spirit, because the wash contains some small quantity of acids, which with the aid of an excessive heat acts upon the metal, as all other acid solvents do upon metals in proportion as they are assisted by heat: and this is perhaps the reason of the blueish colours discernible in spirit distilled with a violent fire.

But supposing that a rapid distillation cannot produce any effects hurtful to health, *per se*, it is at least self-evident it is excessively pernicious in its consequences, because the rectifier is absolutely obliged to employ poisonous ingredients for the purpose of destroying the empyreumatic and unpleasant taste which the essential oil has communicated to the liquor; and which simple rectifications, however multiplied, cannot by any means effect.

Before I explain these means it will be necessary to observe, that unprincipled distillers, in employing these means, have two different objects in view; namely, to destroy the bad

bad taste of the spirit; and, secondly, to increase the quantity of spirituous matter, and thus to procure by those additions a greater quantity of spirit from a given quantity of wash than they could obtain by a natural process.

To obtain the former object the distillers make use of pure alkali, caustic alkali, and Glauber's salt, which possess a peculiar quality to absorb the essential oil; but, on the other hand, they communicate to the spirit their most volatile particles, which their great volatility renders extremely pernicious, and also impart to the liquor an extremely urinous taste, not less unpleasant; in order to destroy which taste they are obliged to make at the same time use of acids, such as the sulphuric, muriatic, and nitric acids: others employ the crystals of verdigris, or radical vinegar (acetous acid) distilled from crystals of verdigris; or the acid from iron or copper vitriol. These ingredients destroy, in some measure, the bad taste, without increasing the quantity of spirit: for the purpose of attaining the latter end, they have recourse to oleaginous aromatics in general and vegetable oils, which possess an uncommon power to augment the quantity of spirit; but to produce this effect they must be mixed with the liquor before the fermentation: for this purpose they are triturated with a little sugar in a mortar, and by this means they would considerably retard the fermentation; but the use thereof, in order to derive from them all possible profit, requires a peculiar mode of conducting the vinous fermentation. When the distillers wish to give their spirits a vinous taste, they digest strong nitric acid with alcohol for some time, and distil it afterwards, which produces a dulcified nitrous acid, and mix a little of this acid with their spirit, which gives it a flavour resembling that of French spirit of wine.

These are the principal means which the distillers generally make use of: they are very seldom employed in Holland, and by no means necessary for the interest of the distiller. Their mode of proceeding yields spirit of a pleasant and agreeable flavour, and in great quantity; and no artifice can ever equal the taste and flavour which a slow operation, in every stage and part of the process, naturally imparts to the spirit. I must suppose that these practices are more common, if not generally resorted to, in this country; but as chemistry furnishes a great many simple means to discover the alkali and acids in the liquor, the officer whom government employs for the purpose cannot but find it a very easy task to detect the fraud; for example, solutions of bodies precipitated by alkalis, such as vitriol of iron, but chiefly

chiefly alum mixed in small quantities with a little of this spirit, will immediately show the presence of alkalis by a precipitate, and the change which acids produce in blue vegetable colours will prove their presence. A bit of paper tinged with litmus put into the spirit, tincture or syrup of violets, into which are poured a few drops of the spirit, manifest immediately the presence of these acids. Severe punishments inflicted on these fraudulent distillers, who sacrifice to their avarice the health of their fellow-citizens, will go a great way in preventing these frauds; and they would doubtless cease entirely if the duty were laid on the product of the labour of the distillers, that is, on the spirit, or to be paid immediately from the malt or corn, as is done in Bremen, where the distiller pays the duty at the mill, to which he carries his corn to be ground for the use of his distillery, and thus is exempt from all constraint during the whole course of the operation.

The only point which I have yet to consider is, whether there does not exist a method to accelerate considerably the distillation without running any danger of experiencing these bad effects. To this I cannot but answer in the affirmative: you have only to substitute shallow caldrons in the room of deep ones; their diameter must be larger, and they must have a concave bottom. I have made several experiments with a caldron constructed in this manner, and the result was always a purer spirit, and in a greater quantity, with a saving of ten-twelfths of fuel. The reason is this, that a large surface of liquor being exposed to heat, the liquor is heated in a more speedy and even manner in all its parts by a less brisk and strong fire, and evaporates with uncommon rapidity, and can neither contract an empyreumatic taste, nor can much essential oil rise and mix with the spirit, as the power of the fire must be greatly inferior to that which is employed under a common still, where the lower parts of the liquor experience a violent fire before the higher parts are sufficiently heated, and wherein the liquor continues a longer time exposed to the action of the fire, in proportion as the evaporation proceeds more slowly; and this diminution of heat is perhaps the reason why more spirit is obtained, because some part of the finest spirit cannot fail to evaporate when the distillation must be pushed on by a brisker fire; but in this case it is unavoidably necessary that the fire-place be constructed on the principles above described. For the same reasons it is obvious, that it is very profitable to effect the distillation in small caldrons, especially if they are of the common cylindric form,

 both

both in regard to the quantity and quality of the spirit, and also with respect to the fuel: you will not, for instance, draw so good a spirit, and the same quantity, in a caldron of eighty gallons, as in two of forty each; the latter will be emptied twice, and oftener, in the same time which is necessary to empty the large caldron once, and with less fuel, and thus the produce of these two small caldrons will be double of that of a large one in a given time. Before I conclude I must make this observation, that it is extremely easy to make the spirit appear less strong at the proof with the hydrometer. All bodies which are easily dissolved in spirits, and augment their specific gravity, produce that effect; and the sulphureous acid possesses this property in a peculiar degree. Before you subject the spirit to the proof with the hydrometer, you should endeavour to discover the presence of this acid by the proofs above mentioned; and every distiller of fine liquors knows perfectly well, that as soon as he mixes a little sugar with his liquor to sweeten it, the hydrometer loses its effect; but it is extremely difficult to make it appear stronger than it actually is at the proof with the hydrometer. This end cannot be attained but by mixing it with bodies of less specific gravity, such as ether, which, on account of its high price, will not be made use of. I say, at the proof with the hydrometer; for this is widely different from the phial proof, because, on mixing a little oil with spirit so much diluted by water that no more bubbles appear, they may be immediately made to reappear. The petty innkeepers in Holland are extremely expert in this trick; they commonly employ oil of olives, poppies, nuts, or almonds, and in general all sorts of oils, which do not give the spirit a bad taste. These frauds are discovered by diluting these spirits with a great quantity of water, when the oil immediately appears on the surface of the liquid. Before I conclude, I shall here touch upon the question, Whether the residue of the distillation can serve to nourish and fatten cattle? On analysing corn, we find that it consists of an earthy or mucilaginous and a saccharine matter, and of oil and salt. If we further consider, what I have already frequently mentioned, that it is the saccharine matter which exclusively yields the brandy, and that the mucilaginous and earthy matter, together with the salt, remain untouched in the residue, it will not be doubted that this mucilage with the salt cannot but be very nourishing. Experience has proved in Holland that this residue, which is there called *toejol-drank*, possesses very nutritious virtues; the number of pigs which the distillers yearly draw

draw from Westphalia exceeding all belief. They are fattened in a very short time for the use of the navy and merchants, who employ them on board ships for the subsistence of the seamen, who are not supplied there with beef as they are in this kingdom, while other distillers fatten with this residue bullocks and cows; and it is a circumstance worthy of notice, that cows fed with this residue give a considerable quantity of milk. It is thus that the Dutch distiller draws some profit from every thing; nothing is lost with him, and this economy is in general the cause of the low price of geneva.

LVII. *Figure of the Orbits of the new Planets.* By JEROME DE LALANDE*.

THE mean distance from the sun, of both, is 2·77, that of the sun being 1, which gives 95 millions of miles. (See Plate VIII.)

Piazzi or Ceres, discovered January 1, 1801.

Revolution 4 years 7 months 10 days.

Mean longitude January 1, 1804 -	$10^s\ 11^\circ\ 59'$
Annual motion - - -	2 18 14
Aphelion - - - -	10 26 44
Node - - - -	2 21 6
Equation of the orbit - -	0 9 3
Eccentricity - - -	0·097
Inclination - - -	0 10 37

Olbers or Pallas, discovered March 28, 1802.

Revolution 4 years 7 months 11 days.

Mean longitude January 1, 1804 -	$9^s\ 29^\circ\ 53'$
Annual motion - - -	2 18 11
Aphelion - - - -	10 1 7
Node - - - -	5 22 28
Equation of the orbit - -	0 28 25
Eccentricity - - -	0·2463
Inclination - - -	0 34 39

* From the *Journal de Physique*, Brumaire, an. 12.

LVIII. *Letter to Mr.* Arthur Aikin *from Dr.* Thornton.

May 20, 1804.
No. 1, Hind-street, Manchester-square.

SIR,

There is no man on earth fonder of the liberty of the press than I am: but when fools or blockheads presume to *criticise*; what was before a blessing becomes a *nuisance*, misleading for a certain time the public judgment, and wounding the honest feelings of authors. Like Linnæus, I would have silently borne the scoffs and derisions of the mimics, as he calls them, of mankind: but when a man of your character in life stands publicly forward as the editor of a review, in which you accuse me of an ignorance the most gross, and endeavour to explain the manner, by a prophetic vision, how I came to have invented an unheard of planet, openly declaring "that no astronomical book ever mentioned a satellite to Venus," I have esteemed it my duty to retort the accusation, and appeal to the candid decision of the public. I shall quote your own words:—"In imitation of the divines of the sixteenth and seventeenth centuries, who frequently treated their subjects first negatively and then positively, he gives the systems of those philosophers who have formed what he deems erroneous opinions on the subject. These are Dr. Darwin, Buffon, and Will. Whiston. Dr. Darwin's hypothesis of the original formation of suns, gives him an opportunity of laying before his readers a concise view of astronomy, from which we learnt, to our *inexpressible surprise*, "that Venus as well as our earth has its satellite, and that this satellite of Venus was discovered in the last century." Had Dr. Thornton claimed this discovery himself, the authority of *so great a man* would have been indisputable; and we must have admitted it as a fact, even though the new secondary planet should still continue to elude the sight of Dr. Herschel, of the astronomer royal, and of every other astronomer in the world. But as we are told that the discovery was made in the *last century*, it must have been known to *others* as well as to *himself*; and as no trace of it is to be found in any professed treatise of astronomy, we may be allowed to doubt on the subject, and to suspect that Dr. Thornton has asserted *what is not true*. Long did we puzzle ourselves with attempting to investigate the source of the *error*; and so continually did it agitate our minds, that for some time we were deprived of our nightly rest; and we know not what might have been the effect upon our health and spirits, or whether we should ever have been equal to the *severe task* of writing *this review*, if

if we had not happily been freed from our anxiety by a kind of vision between sleeping and waking, which, on account of the solemn mysterious stillness by which it was accompanied, is in our estimation entitled to more credit than the frantic ravings of an intoxicated Delphic prophetess. We therefore do not hesitate to pronounce with oracular confidence, that once upon a time Dr. Thornton, happening to be left alone in the parlour of a friend, took up a book on astronomy, which lay by chance in the window, or on a table, and opened it at the chapter where an account is given of the discovery made soon after the invention of the telescope, that Venus, in different parts of her orbit, has different phases, like those of the moon; and that, unwilling to lose the knowledge which he had thus incidentally obtained, as soon as he got home he carefully entered it in his *immense common-place book* *; but through the *natural infirmity*

* Having long had the pleasure of Dr. Thornton's acquaintance, we think it justice to that gentleman to state, that he is remarked by those who know him for the strong retentive powers of his memory, having written the whole of his Philosophy of Medicine and of Politics without the least memorandum paper; and that, trusting entirely to his memory, he never had a common-place book in his life; nor even when lecturing *viva voce* does he refer to any notes whatever. We do not state this from any objection we have to common-place-books, for we think the use of them might sometimes keep people from committing themselves. Such abuse as this deserves any name but that of criticism. We are confident not only that Mr. Aikin did not write this review, but that it must, by some accident, have escaped his correcting eye; for we have also the pleasure of his acquaintance, and we know that he cannot calumniate, or commit willingly an act of injustice. Can the following be considered as ingenuous fair criticism?—" But we are reminded that we have unaccountably overlooked the capital beauty of the publication; and that its merits, and its acceptableness with the public, rest chiefly on the excellence, the splendour, and magnificence, of the engravings. We have all along been sensible of it, and in this respect are not at all disposed to be sparing of our praise. *Our* praise, however, is not needed. The smaller uncoloured botanical plates in general, but especially the larger coloured ones, do the highest honour to the artists, and will be lasting monuments of the fine taste and masterly execution which characterize the British nation in the present age. But when Dr. Thornton claims a share of the fame, we are reminded of a farce, which, in our play-going days, afforded us much amusement: it is called, if we mistake not, A Peep behind the Curtain." Dr. Darwin, speaking of these plates, in his Phytologia, says: " I beg leave to recommend to the public the superb picturesque botanical plates of Dr. Thornton, which I suppose to have *no equal*." Now are the public under no obligation to Dr. Thornton, who risks his fortune in order to afford them gratification? When were picturesque botanical plates published before? Is not this the improvement of Dr. Thornton? And who are the artists who have executed them? Mr. Reinagle, associate of the Royal Academy, and Mr. Henderson.

 Are

infirmity of his *memory*, and the *habitual confusion* of *his ideas*, he *mistook* the *appearance* for the *reality*, and has ever since believed that Venus *has a moon*, instead of being in some respects *like one*."

Without dwelling on the observations which you make on my work in general, I shall confine myself to the present point, as you accuse me of having published a direct falsehood.

Had my work been professedly on astronomy, I should have given my authorities; but as the fact denied in your Review was only added as a note, and incidentally mentioned, I thought myself excused till called upon to vindicate my own veracity from such animadversions. My astronomical observations were extracted from Bonnet's *Contemplation de la Nature*, vol. iv. part 1. This author says (page 7), "Venus and the earth have each a satellite," and adds in a note the following proofs in support of what he advances*:

"A great many doubts have been started in regard to the existence of the satellite of Venus, and it has been suspected that the accounts given of it by different observers arose chiefly from some optical illusion. But those who take the trouble to consult the article Venus in the Supplement to the French *Encyclopédie*, vol. xvii, will entertain no doubt of the existence of this planet. They will find there an observation

Are these gentlemen botanical painters? No. They must then have been done under his eye and direction, and Dr. Thornton in this way participates in their fame.—EDIT.

* On a élevé bien des doutes sur l'existence du satellite de Vénus; on a soupçonné que ce qui en avoit été rapporté par différens observateurs, tenoit principalement à quelqu'illusion d'optique. Mais, si l'on prend la peine de consulter l'article *Vénus* du Supplément à *l'Encyclopédie* de Paris, tom. xvii, on ne doutera gueres de l'existence du satellite dont il s'agit. On y verra l'observation du grand Cassini de 1686, celles de Mr. Short de 1740, de Mr. Montaigne de 1761, du P. la Grange de la même année, de Mr. Montbaron de 1765. C'avoit été sous la forme d'un petit croissant que le satellite s'étoit montré aux trois premiers observateurs que je viens de citer. Mr. Short avoit été si touché de sa propre découverte, qu'il l'avoit fait graver sur son cachet avec cette devise, *Tandem apparuit*. Le célebre Lambert, qui a comparé entr'elles toutes les observations de ce satellite, a montré leur accord. *Essai d'une Théorie du Satellite de Vénus, Nouveaux Mémoires de l'Académie de Berlin*, an. 1773. Suivant les calculs de cet astronome, la révolution de ce satellite autour de Vénus seroit à-peu-près de onze jours. Il avoit cru qu'on pourroit l'appercevoir sur le disque du soleil, le 1 de Juin 1777, parce que Vénus devoit passer alors très près de cet astre; mais on ne l'y a pas découvert. M. de Mairan, qui ne paroissoit pas douter de l'existence de ce petit astre, avoit indiqué les causes de la rareté de ses apparitions. *Mém. de l'Acad. de Paris*, 1762.

servation of the great Cassini in 1686; those of Mr. Short in 1740; of M. de Montaigne in 1761; of father La Grange the same year; and of M. de Montbaron in 1765. The planet appeared to the first three of these observers under the form of a small crescent. Mr. Short was so overjoyed at the discovery he had made, that he caused it to be engraved on his seal, with the motto *Tandem apparuit*. The celebrated Lambert, who compared all the observations of this planet, has shown how far they agree: *Essai d'une Théorie du Satellite de Vénus*, in the *New Memoirs of the Academy of Berlin* 1773. According to the calculations of this astronomer, the revolution of this satellite around Venus is nearly eleven days. He thought he should perceive it on the sun's disk June 1st, 1777, because Venus would then pass very near that body; but it was not observed. M. de Mairan, who seems not to have doubted the existence of this small star, pointed out the causes why it so rarely appeared."—*Mem. de l'Acad. de Paris* 1762.

Bonnet, in his Philosophical and Critical Enquiries relative to Christianity, calls Messrs. Mairan and Cassini the first astronomers of our times. To say much of Cassini would be an insult to the philosophical world. The life of the illustrious Lambert is in every person's hands*, and the other names are well known to astronomers.

In the *Encyclopædia Britannica*, the reviewer, if unacquainted with the French, would have found a sufficiently long account:—' Cassini, besides the discovery of the spots on the disk of Venus, by which he was enabled to ascertain her revolution on an axis, had also a view of her *satellite* or moon, of which he gives the following account:—" A. D. 1686, Aug. 28th, at 15 minutes after four in the morning, looking at Venus with a telescope of 34 feet, I saw, at the distance of one-third of her diameter eastward, a luminous appearance, of a shape not well defined, that seemed to have the same phase with Venus, which was then gibbous on the western side. The diameter of this phænomenon was nearly equal to a fourth part of the diameter of Venus. I observed it attentively for a quarter of an hour, and having left off looking at it for four or five minutes, I saw it no more; but day-light was then advanced. I had seen a like phænomenon which resembled the phase of Venus, Jan. 25th, A.D. 1672, from 52 minutes after six in the morning to two minutes after seven, when the

* Our readers will find in the pages that immediately follow the present article, a life of this celebrated philosopher.—EDIT.

brightness

brightness of the twilight made it disappear. Venus was then horned, and this phænomenon, the diameter whereof was nearly a fourth part of the diameter of Venus, was of the same shape. It was distant from the southern horn of Venus, a diameter of the planet, on the western side. In these two observations I was in doubt whether it was not a satellite of Venus of such a consistence as not to be very well fitted to reflect the light of the sun, and which, in magnitude, bore nearly the same proportion to Venus as the moon does to the earth, being at the same distance from the sun and the earth as Venus was, the phases whereof it resembled. Notwithstanding all the pains I took in looking for it after these two observations, and at divers other times, in order to complete so considerable a discovery, I was never able to see it. I therefore suspend my judgment of this phænomenon. If it should return often, there will be these two epochas, which, compared with other observations, may be of use to find out the periodical time of its return, if it can be reduced to any rule."

'A similar observation was made by Mr. Short on the 23d of October 1740, about sunrise. He used at this time a reflecting telescope of about 16·5 inches, which magnified between 50 and 60 times, with which he perceived a small star at about 10′ distance from Venus, as measured by the micrometer; and, putting on a magnifying power of 240 times, he found the star put on the same appearance with the planet herself. Its diameter was somewhat less than a third of that of the primary; but its light was less vivid, though exceedingly sharp and well defined. The same appearance continued with a magnifying power of 140 times. A line, passing through the centre of Venus and it, made an angle of 18° or 20° with the equator: he saw it several times that morning for about the space of an hour, after which he lost sight of it, and could never find it again.

'From this time the satellite of Venus, though very frequently looked for by astronomers, could never be perceived; which made it *generally* believed that Cassini and Mr. Short had been mistaken: but as the transits of the planet over the sun in 1761 and 1769 seemed to promise a greater certainty of finding it, the satellite was very carefully looked for by almost every one who had an opportunity of seeing the transit, but generally without success. Mr. Baudouin, at Paris, had provided a telescope of 25 feet, in order to observe the passage of the planet over the sun, and to look for its satellite: but he did not succeed either at that time, or in the months of April and May following. Mr. Montaigne,

taigne, however, one of the members of the society of Limoges, had *better success*. On the 3d of May 1761, he perceived, about half an hour after nine at night, at the distance of 20′ from Venus, a small crescent, with the horns pointing the same way as those of the planet; the diameter of the former being about one-fourth of that of the latter; and a line drawn from Venus to the satellite making an angle with the vertical of about 20° towards the south. But though he repeated this observation several times, some doubt remained whether it was not a small star. Next day he saw the same star at the same hour, distant from Venus about half a minute, or a minute more than before, and making with the vertical an angle of 10° below on the north side; so that the *satellite* seemed to have described an arc of about 30°, whereof Venus was the centre, and the radius 20′. The two following nights were hazy, so that Venus could only be seen; but on the 7th of May, at the same hour as before, he saw the *satellite* again above Venus, and on the north side, at the distance of 25 or 26′ upon a line which made an angle of about 45°, with the vertical towards the right hand. The light of the satellite was always very weak, but it had the same phasis with its primary, whether viewed together with it in the field of his telescope or by itself. The telescope was nine feet long, and magnified an object between forty and fifty times, but had no micrometer; so that the distances above mentioned are only from estimation.

'In four days it went through 155°. Then, as 155° is to four days or 96 hours, so is 360 to a fourth number, which gives 9 days 7 hours for the whole length of the synodical revolution. Hence Mr. Baudouin concluded that the distance of this *satellite* was about sixty of the semidiameters of Venus from its surface; that its orbit cut the ecliptic nearly at right angles; had its ascending node in 22° of Virgo; and was in its greatest northern digression on the 7th, at nine at night; and he supposed that at the transit of the primary the satellite would be seen accompanying it. By a subsequent observation, however, on the 11th of May, he corrected his calculation of the periodical time of the satellite, which he now enlarged to twelve days; in consequence of which he found that it would not pass over the disk of the sun along with its primary, but go at the distance of above 20′ from his southern limb; though, if the time of its revolution should be fifteen hours longer than twelve days, it might then pass over the sun after Venus was gone off. He imagined the reason why this satellite was so difficult to be

be observed might be, that one part of its globe was crusted over with spots, or otherwise unfit to reflect the light of the sun. By comparing the periodical time of this *satellite* with that of *our moon*, he computed the quantity of matter in Venus to be nearly equal to that in our earth; in which case it must have considerable influence in changing the obliquity of the ecliptic, the latitudes and longitudes of stars, &c.'

You, sir, whom I understand to be engaged in the *New Cyclopædia* of Dr. Rees, may perhaps favour the world with a refutation of what has been here advanced; but whatever may be the disputes of the learned in astronomy, I shall hope in future for less censure in adopting what my feeble intellect may at the present period conceive to be the strongest side.

I trust I have stated authority enough from other astronomers for quoting that of Bonnet; and with extreme eagerness I retire from controverting what another is pleased to think and say of me, willingly wishing the same forgetfulness of the insults offered me as the author is willing to ascribe to me on other occasions.

Sir, in concluding, I cannot for a moment allow myself to think that you were actually the writer of the review in question; but as editor I cannot help addressing you, as permitting so severe and, I trust, unfair a criticism, as your work contains, beginning with,

> " To turn the penny, once a wit
> Upon a curious fancy hit;
> Hung out a board, on which he boasted,
> ' Dinner for threepence, boiled and roasted!'
> The hungry read, and in they trip,
> With eager eye and smacking lip:
> ' Here, bring this boiled and roasted, pray.'
> Enter potatoes, dressed each way:
> All stared and rose, the house forsook,
> The dinner cursed, and kicked the cook.
> My landlord found, poor Patrick Kelly,
> There is no jesting with the belly."

I have the honour to be, sir,
With great respect,
Your obedient humble servant,
ROBERT JOHN THORNTON.

LIX. *Life*

LIX. *Life of* John Henry Lambert*.

If amongst the literati, whose merits in the sciences have eternalized their name, those that have acquired their erudition without the assistance of others, merely by dint of their own exertions and industry, be in a superior degree entitled to the notice of the learned; then the man of whose life, character, and writings, we are now going to give an account, deserves undoubtedly, in preference to all others, to be introduced to the acquaintance of our scientific readers; especially as he overcame the most arduous difficulties merely through the unassisted application of his uncommon genius.

Lambert was born August 29, 1728, at Mühlhausen, a small confederate town in Sundgau. His father, Lucas Lambert, whose ancestors had emigrated from France when the edict of Nantes was recalled, was by trade a tailor, and had great difficulty to maintain himself and his family by means of his industry. His limited circumstances determined him to bring up his son for his own profession, and to give him an education conformable to his future situation in life, without, however, totally neglecting the improvement of his mind. He frequented the public school, at the expense of the corporation, till he was twelve years old, and distinguished himself so eminently from the rest of his school-fellows, that his father was at last, by the repeated intercessions of his instructors, and his invincible aversion from the trade for which he was intended, prevailed upon to permit him to study theology. But being soon arrested in the prosecution of his scientific career by a total want of the requisite means, he was at length necessitated to assist his father in his profession.

Whilst he was occupied in this manner, he read with uncommon eagerness all Latin books of which he could obtain possession; and happening in the course of his readings to meet with an old work on mathematics, his decided predilection for this science manifested itself soon in a most striking manner by the ardour with which he studied it, and the complete knowledge he acquired by means of it of the computation of almanacs, notwithstanding the numerous errors he discovered in it, without being able to correct them. The occupations incumbent upon him in the day, obliged him to devote great part of the night to the prosecution

* From the *German Museum*, vol. iii.

tion of his studies: and the money necessary for the purchase of candles, with which he could not expect to be supplied by his parents, he procured by the sale of small drawings, which he delineated whilst he, with his foot, rocked his infant sister. Some workmen being employed, one day, in repairing his father's house, this afforded him an opportunity of putting several questions respecting the practical application of some principles he had found in his book to the builder, who was induced thereby to gratify him by the loan of a mathematical work which he possessed. Words are inadequate to express the joy which he felt on discovering that this work was completely calculated to enable him to correct the errors which he had found in his own book. He now learned from these two books, without any additional assistance, the rudiments of arithmetic and geometry.

His enthusiastic zeal for the sciences prompted at length several men of learning to instruct him gratis, and they had the satisfaction of seeing him improve with a rapidity that exceeded their most sanguine expectations. Thus generously supported, he acquired in a short time a knowledge of philosophy and the oriental languages, and learned to write a very elegant hand, which procured him the place of a copyist in the chancery of his native town, whence he removed in his fifteenth year to the iron-works of a Mr. de la Lampe, situated in the vicinity of his native place, where he was appointed book-keeper, and obtained an opportunity of learning the French language, in which his father could not have him instructed on account of his poverty.

Two years after, Mr. Iselin, of Basle, who then conducted the publication of a newspaper, engaged him in the capacity of amanuensis, and in a short time conceived for him the most tender friendship, of which he gave him numerous proofs as long as he lived. This situation afforded Lambert an opportunity of making further progress in the *belles lettres* as well as in philosophy and mathematics; and his passionate love of the latter science frequently made him neglect his regular occupations. In the year 1748 he was recommended by his patron to baron Salis, president of the Swiss confederacy, as tutor to his children. The excellent library which he found in the house of his new patron, and the leisure hours with which he was indulged, together with the instructive intercourse which he had with all the members of that illustrious family, and with a great number of scientific strangers who visited the baron, proved to him excellent means of satisfying his thirst for knowledge, and enabled him to become more familiarly acquainted with astronomy

nomy and all other branches of the science of mathematics, as well as with physic, physiology, theology; yea, even with jurisprudence, eloquence, poetry, and the Greek, Latin, French, Italian and German languages. His uncommon talent for mathematics now displayed itself in a most conspicuous and decided manner. Pascal's example stimulated him to invent an accounting machine, whilst the numerous occasions he had for an accurate chronometer, actuated him to invent a time-piece of mercury which went twenty-seven minutes without causing the slightest error. Here he also invented his logarithmic accounting-scales, and was likewise, by the error which one of his pupils had committed in the solution of an algebraic proposition, occasioned to turn his mind to the invention of a machine for designing perspective drawings. He surveyed and made a drawing of the country around Coire, and performed numerous physical observations in the mountains of that country. In 1752 he began to keep a regular journal of his daily occupations, which he uninterruptedly continued to the end of his life, and which is highly esteemed by the learned. A literary society being at that time instituted by the most eminent men of learning at Coire, he was chosen one of its first members. In 1753 he was elected member of the Helvetic society, the Transactions of which contain a great many mathematical and physical treatises, communicated by him. After having resided eight years at Coire, he repaired with his pupils in 1756 to the university of Göttingen, where he staid till autumn in 1757; when he, after having been previously nominated a corresponding member of the society of sciences at that place, removed to Utrecht, where he stayed a twelvemonth with his pupils. He made, during his stay at Utrecht, several excursions to Leyden, Hague and Amsterdam, on one of which he became acquainted with the celebrated Muschenbröck, who at first treated him as a tyro in the science of physics, which occasioned a very laughable conversation, whilst he on another published his first work: *De la route de la lumière par les airs*. In autumn 1758 he went with his pupils to Paris, where he gained the esteem and friendship of S. Alembert and Messier, and from thence to Marseilles, where he first lighted upon the idea of his perspective, which in the year following was published at Zürich. He returned to Coire by way of Turin, and in the following year to Mühlhausen, whence he made an excursion to Augsburg, where he became acquainted with the celebrated philosophical instrument-maker, Brander, who afterwards was of great service

to him in executing his ideas, and where he also published his Photometry; enriching thereby mixed mathematics with a new branch. In the same year he was also elected member of the electoral Bavarian society of sciences, on condition that he should give them his assistance, and transmit tracts for their Transactions. He faithfully performed his engagement with that society; but nevertheless experienced a great deal of ill treatment by them, and even was deprived of his salary, which prompted him to return his diploma. He now visited Erlangen, where he published his letters upon the construction of the universe, as well as his treatise upon the principal qualities of the orbits of the comets. In 1763 he went to Leipzig, where he in the year following published his *new* Organon. On an excursion he made in the same year to Berlin, he was introduced to Frederic II., who upon the first interview was convinced that he fully deserved the admiration of all men of science, and ordered him to be elected a regular member of the academy of Berlin; which appointment afforded him full leisure to devote himself entirely to his favourite sciences, and to communicate to the world the fruits of his lucubrations.

A great number of Lambert's treatises are to be found in the Transactions of the literary societies of Leipzig and Berlin; and as many have been printed separately, all these treatises bear the stamp of an eminent genius, who had derived his knowledge more from his own reflections than from books, and always found means of placing the subject of which he treated in a point of view in which it had not been considered before.

His principal metaphysical work is his *Architectonic*. He composed this elaborate work with a view of showing the application of logic in metaphysics, and of evincing the possibility of carrying it to algebraic evidence.

Most of his mathematical treatises were published by himself, in three volumes, under the title of *Beyträge zum Gebrauch der Mathematic und deren Anwendung*, in which almost every branch of mathematics has been enriched with additions and important improvements.

Frederic II. largely added to his pension a short time before he died; and after his death evinced in the strongest manner his sincere concern at the loss which the sciences suffered by it.

Lambert was as universally esteemed for his amiable character, as he was respected for his scientific merits. The manner in which he had been educated had, indeed, left indelible traces of his originally low situation in life, which manifested

manifested themselves by his timid and awkward conduct, by the tasteless disharmony in his dress, the furniture of his apartments, by loud laughter, low jests and antic gestures, by his predilection for glaring colours, coarse viands, and sweet wines, as well as by the pleasure he took in frequently mixing with low companies, in joining in their political disputes, and laughing aloud at their coarse witticisms. But these defects were amply over-balanced by a most excellent heart and uncommon mental perfections. A real virgin modesty and bashfulness, and the most complete chastity and sobriety, an honest and frank manner of thinking, and a decided aversion from all kinds of double dealing and falsehood; a manifest antipathy against all injustice; a prompt and spontaneous reparation of every injury he thought to have committed; the most anxious desire to avoid every cause of dissension and dispute; an inexhaustible patience and forbearance; a total freedom from moroseness and ill-humour; a sincere promptitude to instruct those who sought his society from good motives; the most active compassion, whenever he beheld wretchedness—all these qualities composed in him a harmonious whole. A glowing devotion, which frequently rose to a kind of pious rapture, a lively sense of his dependence on God, and of the imperfection of our knowledge of the Supreme Being, and unaffected humility and veneration towards it, animated him from his early youth to his grave, notwithstanding the change which, in the latter part of his life, took place in some of his religious notions, and afforded him an uninterrupted serenity of mind, frequently suffusing his countenance with a glow of heavenly beauty. He felt the most profound contempt for works that were levelled against the sacred cause of religion, whilst works that ably defended it were read by him with rapture. He was a real cosmopolite, and animated with universal love; but he showed as little individual attachment to any one as predilection for any spot; not even his native country excepted; nor did he betray any mark of the Swiss national character. He took, however, a lively interest in the fate of those whom he esteemed. When professor Sulzer was dangerously ill, Lambert wept the only tear which he ever was seen to shed. He delighted in assisting young men of talents, and in contributing to their improvement.

Unbiassed by vanity and flattery, he judged with impartiality both of himself and others. But the habitude of speaking as decidedly and freely of his own merits and defects as of those of others, made him frequently appear a

boaster to those who did not sufficiently know him. He was wedded, as it were, to his opinions, and relinquished them with great reluctance, when tenable no longer. He generally judged correctly in his own sphere: whilst out of it, when men and business were the objects of conversation, his judgment was frequently glaringly erroneous, and oftentimes even destitute of common sense; either, because he neglected to observe men in their actions, and the course of business, in their real situation, or because his being accustomed to analyse, incapacitated him from discerning by intuition.

His conduct exactly corresponded with his manner of thinking. He proposed to himself certain rules, of the propriety and justness of which he was convinced, and observed them as strictly as the rule of arithmetic in calculating. Hence, nothing could affect the calmness of his mind, or divert him in the slightest degree from the pursuit of his studies. His diligence and assiduity were, perhaps, never excelled, or even equalled by any man; though he never manifested the least sign of that uneasiness which is so common with people of an active mind, and involved in a multiplicity of occupations. His mind was constantly unruffled.

He generally was at his writing-desk from five o'clock in the morning till noon, and from two o'clock in the afternoon till midnight, without indulging himself in any kind of recreation, a solitary walk on a fine day excepted. The most indifferent occurrence led him to mathematical or philosophical analyses; to which he gave himself up so completely, that no object whatever could make the least impression upon him. When he happened to be overtaken by a shower of rain, on a walk, he calculated, whilst running, which was the shortest and driest way. Several of his treatises owe their existence to incidents of this nature. Even in the management of his economical concerns every thing was conducted with mathematical exactness. Whenever he happened to speak in company of metaphysical or mathematical subjects, he took not the slightest notice of the surrounding persons; and his discourses were real dissertations, in which not the least leap or chasm could be discovered, as he always represented his ideas in that order in which they arose in his mind,—and when he was interrupted, resumed his discourse at the exact point where he had stopped.

Considering his ardent and indefatigable diligence, it is very natural that he should have acquired a profound know-

ledge

ledge of several sciences. He was thoroughly acquainted with the theological system of his age, and even well versed in the oriental languages. He had also acquired a considerable knowledge of jurisprudence; but *logic*, *metaphysics*, and *mathematics*, were the leading subjects of his lucubrations. He was uncommonly strong in logic, and was guided by its rules not only in his scientific pursuits, but even in common life. He was extremely profound and acute in the *metaphysical analysis*. He meditated upon the plan of a method of treating all simple notions with the same acuteness and precision, as the notion of quantity is treated in mathematics. His manner of treating every subject was the same which he describes in his Organon. He committed to paper every accidental idea that related thereto; arranged the materials, he collected in this manner, after the usual logical rules; he then endeavoured to fill up all chasms; examined other books, especially vocabularies, in order to collect the whole extension of the notion, and finally revised the subject after a logical table, which he published in the Leipzig Transactions. Mathematics were, however, the principal subject of his meditations and researches. The astonishing greatness of his genius manifested itself particularly in the facility with which he reduced to an easy construction the results of extensive and intricate computations. It clearly appears by his cosmological letters, and his computations relative to the supposed satellite of Venus, how easy it was for him to abstract a theory from a few cases or dates, and to carry it to a high degree of probability and completeness.

But, having derived all his knowledge almost entirely from himself, it was extremely difficult for him to comprehend any thing suggested by others, if he did not light upon it of his own accord. Hence, it was easier for him to *invent*, than to *judge rightly* of the ideas of others.

His memory was uncommonly faithful in matters that related to his favourite sciences; but very indifferent in others. He was intimately acquainted with the history of these sciences, their epochas, and the great men who had formed them; though he was little acquainted with history in general.

He was decidedly averse from composing a system, because he did not think that our knowledge is capable of being formed into a complete whole. He firmly believed that almost every individual had more principles of his own, which depended on his situation; and that in cases of col-

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lision the final determination rarely was the effect of reason, but generally of other decisive powers.

He died Sept. 25, 1777, of a decline, after having rendered to the sciences services that will be recollected with gratitude by the latest posterity. P. W.

LX. *Addition to a Memoir on the Method of giving to Cotton and Linen Thread the Adrianople Red, and other fixed Colours.* *By* J. M. Haussman*.

To give to cotton and linen thread all kinds of durable colours, nothing is necessary but to fix on these threads, in any manner whatever, more or less alumine, after having applied to them a slight stratum of oil. The complete success of the result, however, depends on certain modifications to be observed in the processes.

The numerous trials which I made in dyeing had so much familiarised me with experiments on a small scale, that I at last never failed. It was only after I published my memoir on maddering inserted in the *Annales de Chimie*†, that I experienced any difficulties in the application of oil when operating on a larger scale. Linseed oil, which had always given me a milky mixture in limited proportions with alkaline solution, then speedily separated when I wished to make a larger provision, and under these circumstances the impregnation of the skains became impossible. The case was the same with all the fat oils: fish oil, however, will remain in mixture for a considerable time; but its odour is too disagreeable.

To remedy the inconvenience of the separation of oil in the alkaline solution of alumine, I had recourse to drying oils; that is to say, oil boiled with metallic oxides. Linseed oil boiled with minium, ceruse, or litharge, by means of water to prevent combustion, dissolves a considerable portion of the oxide of lead, and will keep mixed with the alkaline solution of alumine, under the milky form, the whole time necessary for the impregnation of the skains. By employing this mixture in proper proportions, and in the manner I have indicated in my memoir, following strictly in other respects the process such as I have described it, one cannot fail to obtain beautiful and lasting colours. However, notwithstanding the simplicity of this process, I cannot re-

* From the *Annales de Chimie*, No. 144.

† See Philosophical Magazine, vol. xii.

commend

commend the use of it, because it exposed me to the danger of a conflagration in the following manner:

With a view to discover whether red cotton, which had not the requisite fixity, could acquire it by impregnating it with an alkaline solution of alumine, with excess of boiled linseed oil, and drying it, and then boiling it a very long time in bran water, I mixed the alkaline solution of alumine in the proportions of an eighth, a twelfth, and a sixteenth part of boiled linseed oil. I then immersed in this mixture some dozens of skains of dyed cotton, which, after being dried in the open air for a whole day the preceding summer, were placed under the window of my cabinet, on a straw-bottomed chair. Being that day indisposed, I went to bed at seven in the evening, without any uneasiness in regard to my cotton. My children, about an hour after, went into my cabinet to look for some sheets of paper, and observed in the cotton neither heat nor any smell of combustion. All the workmen of the manufactory were in a state of profound sleep, when one of the watchmen of the bleach-field, seeing my cabinet all illuminated, called out "Fire!" and awaked us between twelve and one o'clock in the morning. My sons, knowing that I was not able to get out of bed, and unwilling to lose time in searching for the key, burst open the door of the cabinet, which is an uninhabited and detached building. They entered, notwithstanding the thick smoke and insupportable odour of the oily combustion, and found the cotton and chair so much on fire, that the flame, which rose to the ceiling, had already broken the glass and burnt the frame of the window. They immediately concluded, that this fire could arise only from the spontaneous inflammation of the cotton impregnated and covered with boiled oil, since no person had entered the cabinet either with a lighted pipe, or with any other matters in a state of combustion. Observing that several persons in the manufactory refused to assent to this explanation, I again impregnated some dozens of skains of old cotton, which had been badly dyed, in the same manner as the burnt cotton. I then dried them in the open air; and seeing that the weather threatened rain, I exposed them on a rope, extended above the court, desiring one of the night watchmen to look at the cotton every quarter of an hour, and to throw it into a bucket of water as soon as he should see it begin to become heated. But as the man could not conceive the possibility of the spontaneous inflammation of cotton, as he himself acknowledged, he went his rounds without so much as looking towards the court. At length, however,

however, he came back to rest himself, and, by the great light he perceived, was convinced of what I had foretold would be the consequence of neglect. Finding that the cotton and rope were both burnt, he took the bucket of water to extinguish the supporters, which were already both on fire.

About fifteen years ago, with a view of preventing similar dangers, I made experiments at Colmar on spontaneous inflammations. I mentioned the probability of fires being occasioned by warm bodies, or bodies tending to be heated, when deposited inconsiderately in places to which fire may be communicated. The bodies of this kind, which I mentioned to those present, who were not sufficiently acquainted with the phænomena of spontaneous inflammations, are roasted coffee, cacao, fermenting plants, ointments made with metallic oxides, inclosed quite hot in wooden barrels, bales of raw cotton, as well as linen or flax heaped on each other at a warm temperature, and even linen which has been ironed and put warm into drawers; in a word, all bodies covered with oil, such as silk and skains of cotton. I showed them besides, that in all cases where the oxygen of the atmosphere is rapidly attracted and absorbed by any cause whatever, the caloric, which served as a base to the oxygen and gave it the qualities of gas, or elastic properties, is disengaged in such abundance, that if the absorbing bodies are susceptible of taking fire, or if combustible bodies are in the neighbourhood, a spontaneous inflammation will take place.

To prove to the persons present, to whom chemical experiments were not familiar, the theory of these inflammations, I made the following experiments:—1st, The incandescence of a mixture of iron filings and sulphur kneaded in water.—2d, The inflammation of boiled linseed oil by means of highly-concentrated nitric acid.—3d, The inflammation of phosphorus in atmospheric air, as well as in pure oxygen gas, placed for that purpose in a porcelain capsule over boiling water, in order to separate the molecula by fusion without having recourse to friction.—4th, The inflammation of phosphorated hydrogen gas by the contact of the atmosphere—an imitation of will-with-the-wisp.—5th, The combustion of pyrophorus thrown into the atmosphere, and in pure oxygen gas.—6th, The reduction into a charry igneous mass, produced by the action of the atmospheric air of torrefied bran put quite hot into a bag, the texture of which was not too close.

I was well aware, that essential or volatile oils become resinous,

sinous, and that drying oils boiled with metallic oxides become thick and hard in consequence of their combination with oxygen. It was also for this reason that my skains, covered with a mixture of boiled linseed oil, were exposed during the whole day to the air, extended and insulated on poles; but I then supposed them to be saturated with oxygen, and consequently incapable of producing the least accident. I was so secure in this point that I caused a great deal of impregnated cotton to be dried at several times in warm apartments; they were not deranged but at the moment when they were washed in order to be dyed. It may however be possible that the proportion of a thirty-sixth part of boiled linseed oil, mixed with an alkaline solution of alumine, may be insufficient to excite spontaneous inflammation in skains of cotton heaped up after they have been dried. Those, therefore, who are induced, on account of the simplicity of the process, to employ a mixture of boiled linseed oil with an alkaline solution of alumine, must take the precaution to leave the skains extended and insulated on poles, until they are to be washed, previous to the operation of dyeing, which, together with the brightening, completely removes the excess of oil, and leaves only the portion saturated with oxygen; so that no fears need afterwards be entertained.

Since the publication of my memoir, I have convinced myself that the simplest brightening of Adrianople red, by which the liveliest and most durable shades are obtained, consists merely in very long ebullition in bran water in a boiler furnished with a cover, having in the middle a pipe to suffer the vapours to escape, and prevent the bursting of the vessel; care only must be taken to renew the water as often as it becomes red; that is to say, two or three times at the commencement of the ebullition. Without this precaution the skains would continually resume the fawn-coloured parts which the bran water removes, and would never acquire a bright colour.

One may avoid all danger without lessening much the simplicity of my process, whether the skains be heaped up or not: nothing is necessary but to apply at two different times a stratum of olive oil, very much divided, after they have been well lixiviated, washed, and dried. For this purpose, a ley is formed of carbonate of potash or soda, which indicates one degree, or a degree and a half, of the areometer for saltpetre. Some drops of olive oil are then dropped into it, to try whether the result will be a milky mixture, or whether the oil will ascend in its natural state to float over the

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ley; for, as the alkaline carbonate may contain more or less heterogeneous parts, in that case the ley must be weakened or strengthened by a new portion of alkali, until it absolutely assume a milky appearance by the mixture of oil. When the ley is properly proportioned, thirty-two parts of it must be mixed at first gradually and then more rapidly, continually stirring it, with one part of olive oil. This milky mixture will keep a long time; and if it be observed that the oil attempts to float under the form of cream, the mixture must be again stirred. The impregnation of the skains should be intrusted to workmen most experienced in this operation, because an exact distribution of the oily parts has a great influence in regard to the equality of the shades. Each workman ought to put as much of the milky mixture into any vessel as will admit of a certain number of skains to be squeezed and twisted in it with facility. This labour must be continued, always taking the same number of skains and the same quantity of milky mixture. The part which has been expressed, each time, must be poured into a vessel apart; and the quantity of oil which the skains appear to have absorbed must be restored, if the little value of this residuum, in consequence of its containing but a small quantity of oil, does not make it be rejected. The impregnation may be effected in the whole mass of the milky mixture; but in this case it will be necessary to continue to replace the quantity of oil which the skains may have absorbed, as soon as a diminution is observed in the intensity of the milky appearance. Expertness in this process may be easily acquired by practice. After the whole skains have been dried together, they must be impregnated a second time as before without being previously washed; and when they have been dried they may be impregnated, as I have mentioned in my memoir, either once, two or three times, in the alkaline solution of alumine, pure and without any mixture: by immersing the skains, shades more or less dark will then be obtained according to the number of impregnations.

To obtain, however, bright and at the same time uniform shades, it will be better to employ three impregnations, properly weakening the alkaline solution. One may then impregnate three times successively in this concentrated or weakened solution without previous washing: by these means the manipulations, which are often tedious and troublesome, may be shortened; but in this case it will be necessary to examine the solution from time to time, to see whether what the impregnated and dried skains discharge in it do not render it too strong.

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In re-dyeing shades of red, it will be necessary to ascertain first whether they have been brightened by means of boiling bran water, or by soap and alkalies. In the first case they will become darker, by still attracting colouring particles of the madder; in the second they are weakened, and lose the excess of alumine, without which repeated dyeing can produce no effect. The removal of this excess of alumine may be prevented by substituting for soap and alkalies, to produce crimson shades, a portion of the alkaline solution of alumine, which must be added to the bran water towards the end of the brightening. Real Adrianople reds become much darker by re-dyeing them, and turn brown by the test of ebullition in water alkalized by ashes: these reds change only very little before they are re-dyed. In general, reds become brown more or less disadvantageously according to the time they have been boiled in brightening them. As the real Adrianople reds have a strong smell, it is probable that the Turks employ fish oil, which they add directly to the alkaline solution of alumine, or mix with a very weak ley of alkaline carbonate.

The processes for dyeing Adrianople red can be infinitely varied; for in whatever manner and by whatever solvents, whether acids or alkalies, the alumine may have been fixed on the skains, when a light stratum of oil has been applied reds more or less bright will be obtained, according to the precaution employed in maddering and brightening.

It appears to me more difficult to explain the reason why oils combine so easily with caustic alkalies to form soaps, and do not admit of being mixed with concentrated leys of alkaline carbonates, while they form a kind of artificial milk with these leys when very much diluted, because one might suspect a tendency to combination in such milky mixtures. A mere suspension of the integrant oily moleculæ, which would take place rather in the diluted ley than in the same ley more concentrated, is equally difficult to be explained.

It remains that I should rectify an injury done to the process for dyeing real Adrianople red in other manufactories. What was shown to me was only of the most inferior quality. I have seen some since equal to the finest and most durable that can be produced. So that I am inclined to think that the merchandize of the Turks, like that of all other nations, is suited to the price which the purchaser wishes to give.

I must observe also, that among my burnt cotton there was some both times which had been impregnated with a weak

weak ley of carbonate of soda and boiled linseed oil in the proportion of an eighth, a twelfth, and a sixteenth. It therefore remains to ascertain whether this cotton will sooner catch fire than that impregnated with a mixture of the alkaline solution of alumine and boiled linseed oil in the same proportions. As the latter mixture is susceptible of attracting a little of the moisture of the air, I am inclined to think that cotton treated with the first will inflame sooner. The trials which I continue to make in regard to the use of gall nuts in dyeing Adrianople red, induce me to believe that it is by the formation of a gallate of alumine that alumine is fixed upon cotton, that the gallic acid may be afterwards separated by an alkaline carbonate before the process of dyeing is begun. When I have acquired certain information on this subject, I shall not fail to publish the result.

LXI. *On Spontaneous Inflammations.* By C. Bartholdi, *Professor of Natural Philosophy and Chemistry*.*

The name of spontaneous inflammation is given to that manifested in a combustible body, without its being in immediate contact with a body in a state of inflammation.

Combustion of this kind may be occasioned by different causes, the principal of which are:

1st, Violent friction.

2d, Action of the sun.

3d, The disengagement of the caloric produced in bodies though not combustible, but brought near to combustible bodies, to which they may communicate such a degree of heat that they inflame by the contact of the air.

4th, The fermentation of animal and vegetable substances heaped up in a large mass, which are neither too dry nor too moist, as hay, dung, &c.

5th, The accumulation of wool, cotton, and other animal and vegetable substances, covered with an oily matter, and particularly a drying oil.

6th, The boiling of linseed oil for printers ink, of varnish, and in general of every fat matter.

7th, The torrefaction of different vegetable substances.

8th, Sulphurized and phosphorized hydrogen gas disengaged in several operations of nature, the last of which in particular inflames merely by the contact of the atmospheric air

* From the *Annales de Chimie*, No. 144.

air even at a low temperature, and which often presents itself at the surface of the earth like a small flame, known under the name of *will-with-the-wisp*, in places where animal substances in a state of putrefaction have been buried: if there are other combustibles at that time on the spot where the disengagement takes place, they may readily be kindled.

9th, Phosphuret of lime and of potash which may be formed in the preparation of charcoal, especially in that of turf and some sorts of wood which grow in marshy places. This charcoal, when wet, or by merely attracting the moisture of the atmosphere, forms phosphorated hydrogen, which by the contact of the atmospheric air inflames, and may set fire to the whole mass of charcoal.

10th, The phosphorus which is sometimes formed, though rarely, in the carbonization of different kinds of wood, without being combined either with lime or potash in the state of phosphuret. This charcoal does not inflame spontaneously at the common temperature of the air; but it may produce a detonation when struck with nitrate of potash, or some other nitrates or metallic oxides to which oxygen weakly adheres, and which are found in a state of thermoxide retaining a great deal of latent caloric.

1. *Friction.*

It is generally known that two bodies when rubbed against each other become heated. The intensity of the heat produced depends on several circumstances, and varies chiefly in the ratio of the duration of the friction, and of the nature and surface of the rubbed bodies. If the friction takes place between combustible bodies, such as wood, the heat it excites may often be sufficient to inflame it; if the bodies are not combustible, such as stones, or little combustible, as metals, they do not inflame themselves; but they may communicate to other combustible bodies around them such a degree of heat that the latter will inflame by contact with the atmospheric air.

D. Falcani repeated the experiments long known for obtaining fire by the friction of two pieces of wood, giving to one of the rubbing pieces the form of a tablet, and to the other that of a spindle or cylinder: the result of some of these experiments will be sufficient to show, that, in the construction of machines and instruments, more attention ought to be paid to the choice of the wood destined to be exposed to mutual friction.

Cylinders.

Cylinders.	Tablet.	Duration.	Effect.
Box wood - -	Box - -	5 min.	Sensible heat.
Ditto - - -	Poplar -	Ditto	Ditto
Ditto - - -	Oak - -	Ditto	Ditto
Ditto - - -	Mulberry	3 -	Considerable heat and smoke
Ditto - - -	Laurel -	Ditto	Ditto
Laurel - - -	Poplar -	2 -	Ditto
Ditto - - -	Ivy - -	Ditto	Ditto
Ivy - - - -	Box - -	3 -	Ditto
Ditto - - -	Walnut -	Ditto	Ditto
Olive - - -	Olive -	Ditto	Ditto
Mulberry - -	Laurel -	2 -	Consid. heat, smoke, and blackness
Ash - - - -	Oak - -	5 -	Sensible heat
Ditto - - -	Fir - -	Ditto	Ditto
Pear-tree - -	Oak - -	Ditto	Ditto
Cherry - - -	Elm - -	Ditto	Ditto
Plum - - -	Apple-tree	Ditto	Ditto
Oak - - - -	Fir - -	Ditto	Ditto

Changing the experiment, and rubbing a cylinder of one of the kinds of wood between two tablets of the other, a cylinder of poplar for example between two tablets of mulberry wood, the increase of the rubbed surfaces which are in contact with the air produced a heat much more considerable, and almost the whole of the kinds of wood above enumerated took fire.

The effect of friction still varies according as the woods employed, especially if they are of the same kind, are rubbed in the direction of the fibres, or when the fibres cross each other. In the first case, the friction and heat are much more considerable than in the second.

In large machines where there is much friction, heating may be prevented by continually directing a current of cold water on the rubbing surfaces: in common machines, carriages, &c. it is diminished by covering the surfaces with an oily matter. There are many instances, during the great heats in summer, of carriages and other machines exposed to violent motion inflaming, because care has not been taken to grease them. Grease, by hardening on the rubbing surfaces, instead of lessening the friction increases it; and as this covering is highly combustible, it renders spontaneous inflammation more easy. In many cases, therefore, it is better to rub the machines with soap, talc, plumbago, or other

other substances, which without being oily are very unctuous to the touch.

2. *Action of the Sun.*

The strongest heat is produced, all sorts of combustibles are kindled, and the most refractory substances are fused by exposure to the sun's rays concentrated by means of lenses or concave mirrors. It may happen that other bodies are in such a condition as to produce without our will the effects of lenses and of burning mirrors: though these effects are rather physical than chemical, it is of importance to make them known, in order to guard against the danger of them. We have instances of fires produced by glass decanters filled with water and exposed to the sun in an apartment. When the form of the vessel is nearly similar to that of a lenticular or spherical glass, the rays are refracted, and produce, by uniting in the focus, a heat capable of setting fire to combustible bodies placed in it.

3. *Heat excited in non-combustible Bodies.*

It is well known that quicklime immersed in water, or merely moistened, produces a considerable degree of heat. It has even been employed with success for heating at a small expense apartments, hot-houses, hot-beds, &c. This property which quicklime has of disengaging a great deal of caloric by contact with the air, and that no less dangerous of dissolving and corroding animal substances immersed in it, require the greatest precautions where considerable depots of quicklime are formed. To preserve it, care must be taken to guard it from the contact of the air, and from moisture of every kind; and particularly to remove from its neighbourhood all combustible bodies, such as wood, hay, straw, &c., which might inflame spontaneously should the lime contract the least humidity. The *Journal de la Haute-Saône* gave an account last year of the burning of a barn, one of the partitions of which being wood had caught fire, because a heap of quicklime, intended for repairing the farm-houses, had been carelessly thrown against it.

A great number of similar phænomena take place in nature, where bodies, by changing their composition, or contracting new combinations, become so heated, or disengage so much caloric, that other combustible substances around them may be inflamed.

4. *Fermentation of Animal and Vegetable Substances.*

Most animal and vegetable substances, if heaped upon each

each other while they still retain their moisture, enter into fermentation; a change is effected in their composition, and they often become so much heated as to inflame. In this manner, haystacks, turf, flax, hemp, straw, and heaps of rags in paper manufactories, take fire.

The principal precautions ought to be employed in regard to hay: if cut in a rainy season, it is generally stacked before it is completely dry, and in this state it is the more disposed to ferment and become hot. As soon as a stack of hay is observed to be in a state of fermentation, care must be taken not to throw it down too speedily. The exterior strata ought to be slowly detached one after the other. When an opening is made in the middle of a heated mass of hay, it almost always happens that the fire suddenly bursts forth.

Nothing, however, is easier than to prevent such fatal accidents. When it is apprehended that hay about to be stacked is not completely dry, it will be sufficient to strew over each stratum a few handfuls of muriate of soda (common salt). The expense in this case ought to be a consideration of no importance; for the salt, by absorbing the moisture of the hay, not only prevents its fermentation, and the inflammation which thence results, but it adds also to the hay a savour which excites the appetite of the cattle, assists their digestion, and preserves them from a great many diseases.

During the great heats of summer it often happens that heaps of dung inflame spontaneously. Great care therefore must be taken to water dunghills from time to time, and to keep them at a certain distance from houses, both to prevent fires and for the sake of salubrity.

5. *The Accumulation of Animal and Vegetable Substances covered with Oil.*

If animal and vegetable substances heaped up in a large mass can be inflamed in consequence of the heat produced by their decomposition, this accident is more to be apprehended when they are covered with oily matters, and especially a drying oil.

Besides the accident which happened at the manufactory of Lagelbart, and of which my colleague Haussman has given an account, and the fire which took place in one of the finest manufactories at Sainte Marie-aux-Mines, we have other instances of wool, stuff, and pieces of cloth which were not scoured taking fire in magazines when folded up, and even during the time of their conveyance from one place to another, when heaped upon each other.

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This is principally to be apprehended when linseed oil is employed in the manufacturing of cloth, or any other oil drying of itself, or rendered drying by oxide of lead.

In cloth manufactories, therefore, no oil but olive or rape oil ought to be employed for greasing wool.

It sometimes happens that in boiling flowers and herbs in oil, which is the case in several pharmaceutic operations, these herbs, after being taken out and dried, inflame spontaneously: care, therefore, must be taken, when they are thrown aside, not to heap them up near other combustible bodies.

We have several instances of ships having been burnt in port either by the spontaneous combustion of cordage heaped up and strongly covered with pitch, or of a mixture of boiled linseed oil and lamp black inclosed in a bag.

6. *The Boiling of Oily Matters.*

In the preparation of some kinds of varnish, such as printers' ink, where in general linseed oil boiled to a certain consistence is employed, it often happens that the oil inflames, if the necessary precautions are not taken. The same effect is produced in melting butter, tallow, or any other greasy substance, if it be too much heated; so that in these operations every other combustible body should be kept at a distance, and a covering should be in readiness to place over the vessel as soon as the matter has caught fire: care also ought to be taken not to pour in water, which, instead of extinguishing the fire, would give more expansion to its activity.

7. *Torrefaction.*

There are many vegetable substances which by torrefaction acquire an increase of their property to inflame spontaneously if inclosed in bags of cloth, which leave them in contact with the surrounding atmosphere. Of this kind are sawdust, burnt coffee, the farina of gramineous and the fruits of leguminous plants, such as beans, lentils, pease, &c.

There are several instances of fires breaking out in stables by a bag of torrefied bran applied to the neck of a diseased animal, and which inflamed spontaneously. The people in the country persist in employing this remedy, for which others more efficacious and less dangerous might be substituted. At any rate, they ought to take care not to inclose the bran in cloth either too hot or too much torrefied.

Brewers, after causing the barley and other grain which

they use for beer to germinate, dry it in a kiln or stove, except that destined for pale beer; and they generally dry it in a greater or less degree, to give to the beer a colour more or less dark. If the grain when taken from the kiln is put warm into sacks, it sometimes happens that they inflame, and occasion fires in brew-houses.

8. *Sulphurized and Phosphorized Hydrogen Gas.*

Subterranean fires and volcanoes are generally ascribed to the decomposition of pyrites and metallic sulphurets buried in the bosom of the earth. These pyritous masses are decomposed by the contact and concurrence of water and air, and the decomposition is always accompanied with a great expansion of caloric, and a disengagement of a highly inflammable gas called sulphurized hydrogen gas. This gas inflames at an elevated temperature, and may communicate inflammation to the sulphur of pyrites, to coals, and other bituminous matters with which they are in general accompanied.

Similar inflammations are observed sometimes in the neighbourhood of coal mines. In working coal mines, veins and insulated pieces of pyrites are often found: as pyrites always communicates a bad quality to coal, the miners generally lay it aside and take it out of the pit. If these heaps of pyrites, intermixed with coal, are then exposed to the alternate action of the sun and rain, they become heated, and inflame. Great care must therefore be taken that such heaps of pyrites be removed from all combustible bodies to which they would necessarily communicate inflammation. There are many operations in nature in which sulphurized hydrogen gas is produced; but it often forms other combinations, according as it is dissolved in water, or is disengaged at a temperature too low to be able to inflame.

When phosphorus is boiled in a solution of potash or of lime, there is disengaged phosphorized hydrogen gas, which being much more combustible than sulphurized hydrogen gas, inflames at a low temperature as soon as it comes into contact with atmospheric air. This gas, which in chemical experiments exhibits the beautiful spectacle of a fountain of fire over water, is produced naturally by the putrefaction of animal substances which have been buried. The flames often seen to issue from the earth, and which are known under the name of will-with-the-wisp, arise only from phosphorized hydrogen gas: as these fires generally appear in the open fields in places where they are not in contact with

dry combustible matters, they rarely produce disagreeable accidents; but it is disengaged also in forests, and it may happen in very warm summers, when the grass and bushes are entirely dry, that the gas in combustion will meet with these combustible matters, set fire to them, and in this manner burn the whole forest. We ought not therefore, on too slight grounds, or without sufficient reason, to ascribe to malevolence or to incendiaries those fatal events which sometimes are the result of causes purely natural.

9. *Sulphuret and Phosphuret of Lime and Potash formed during the Combustion of several Vegetables.*

When gypsum (sulphate of lime) or any other sulphate, either earthy or alkaline, is strongly heated with charcoal of wood, or in general with any combustible matter which by heat is reduced to charcoal, sulphur is formed. These salts produce sulphureous waters, if animal or vegetable substances are suffered to remain in water in which they are dissolved, so that very often nothing is necessary but a little sulphate of lime to communicate to stagnant water the odour and taste of sulphur.

Pyrophorus is obtained by calcining common alum or sulphate of potash with sugar, farina, or any matter which becomes reduced to charcoal.

The inflammation of pyrophorus, which takes fire merely by the contact of damp air, arises only from the sulphuret of potash, which by attracting the humidity of the air becomes heated to such a degree as to set fire to the carbonaceous matter around it, and which being in a state of great tenuity is the more disposed to burn.

But as many of our common combustible matters contain sulphuric salts, it may happen that in their combustion there is sometimes accidentally formed some pyrophoric matter, which remains in the residuum of the combustion; especially if the combustible matter is not entirely consumed, and if a part of it only is reduced to charcoal; which sometimes happens in fire-places where the combustibles are not burnt in grates, and where the ashes are not separated from the charcoal. There have been instances of houses being set on fire by ashes intermixed with charcoal taken too soon from the hearth and deposited in places where they were surrounded by combustibles, which they set fire to by spontaneous inflammation. Happily these causes of fires rarely occur; for pyrophorus does not long retain its property of inflaming, and it is often decomposed soon after it has been formed, without being able to produce that

that disagreeable event. Care, however, ought always to be taken not to put ashes newly burnt, and which are still mixed with charcoal, in places where they may have a communication with combustibles.

The formation of a pyrophoric matter is remarked chiefly in the preparation of common soda, which is obtained by the incineration of several marine plants containing a great deal of sulphate of soda, and which in burning furnish always a greater or less quantity of sulphur according to the manner in which the operation is directed.

The formation of the phosphuret of lime has great analogy with that of the sulphuret of lime. Though the phosphoric acid is not found so often in vegetables as the sulphuric acid, it however exists in them in much larger quantity than has hitherto been supposed; it is found chiefly in the greater part of plants which grow in marshy places, in turf, and in several kinds of white wood. By reducing these kinds of wood to charcoal there is sometimes formed a small quantity of phosphorus, which may remain combined with the same bases which retained the phosphoric acid before the combustion: phosphorus, by contracting other combinations, may be no longer susceptible of producing any accident; but it may happen also, by the concurrence of various circumstances, that charcoal impregnated with any phosphuret, when exposed to the action of warm and moist air, will disengage phosphorated hydrogen gas, which by the contact of the atmospheric air may kindle, and communicate inflammation to the mass of charcoal.

Two instances of this kind of spontaneous combustion took place in the powder manufactory of Essone in the years 8 and 10. The first time the fire broke out in the box for sifting the charcoal, and the second time the charcoal repository took fire, without room being left for suspecting that it could arise from any thing but spontaneous inflammation. The different reports on these two events were inserted in the public journals, but the explanations given were not sufficiently satisfactory. It appears very probable that they were occasioned by some phosphorus contained in the charcoal; and this explanation is the more founded in reason, as the alder wood used at Essone as well as in most of the powder manufactories, and which on many accounts deserves the preference over other kinds of wood for the making of gunpowder, contains phosphoric acid; at least that which grows in our neighbourhood does.

Charred turf begins to be used in some manufactories, and for different operations; but as it is much disposed to spontaneous

spontaneous inflammation, the use of it ought to be abandoned, or great care should be employed in preserving it. Magazines of this substance, both at Paris and other places, which were uncovered, have been inflamed by the combined action of the heat and rain.

10. *The Phosphorus contained sometimes in Charcoal.*

It may happen also that the small quantity of phosphorus, which is sometimes formed in the carbonization of different kinds of wood, without uniting to lime or to potash, remains combined with the charcoal, which in this case does not disengage phosphorated hydrogen gas, and does not easily inflame by the mere action of water or moist air, but which may produce a violent detonation when struck with saltpetre (nitrate of potash). It is very probable that the three successive explosions which took place in the powder-mill of Vonges were in part owing to a similar cause.

Charcoal in general has a great influence on the different products of nature and the arts. It is often observed in forges and founderies, especially those of iron, that the products vary according to the nature of the charcoal employed. The bad quality found sometimes in iron of being cold short is generally ascribed to phosphoric acid contained in the ore; but as the ore by the same processes furnishes in the same foundery one kind of iron better than another, the difference appears often to arise in part from the charcoal.

LXII. *Remarks on Men of gigantic Stature, and particularly on the Irish Giant, O'Brien. By Mr.* Blair, *Surgeon of the Lock Hospital, &c. &c.**

The existence of whole nations of gigantic persons may well be questioned; but there can be no reasonable doubt of the reality of certain individuals, whose stature has greatly exceeded that of men in general. The exact height of Og, king of Bashan, has been variously computed; some supposing him to have been more than twelve English feet, while others think his stature did not exceed eleven feet. In like manner, the giant Goliah is generally computed to have been about nine feet nine inches; but bishop Cumberland supposes he might have been full eleven feet high. The emperor Maximinus is said to have been nine feet; and

* Communicated by the Author.

 several

several other Romans of equal stature are reported to have lived in the reign of Augustus, &c. Accounts are contained in the Philosophical Transactions, of human skeletons dug up in England, measuring eight and nine feet in length, which probably were Roman. Credible relations among the moderns are likewise to be found, of men and women fully equal in size to any of the antients whose existence can be verified; although I think no credit can be attached to the fabulous and contradictory stories of the Patagonian people, who have been represented as a nation of giants. A commissary on board Le Maire's fleet affirmed that he had measured the bones of men, in sepulchres of South America, between eleven and twelve feet high; and Turner, the naturalist, declares that he had seen on the Brazil coast a race of very gigantic savages, one of whom measured twelve feet. The declaration of Turner is, moreover, rendered credible by monsieur Thevet, who, in his description of America, published at Paris 1575, tells us he saw and measured the skeleton of a South American, then not many years dead, which was eleven feet five inches in length; his skull was three feet one inch in circumference, and the leg-bones full three feet four inches long. To these remarkable instances may be added a well-proportioned living man, whom Diemerbroeck saw at Utrecht, measuring eight feet six inches, and who is likewise mentioned by Mr. Ray. Also a youth, seen by Dr. Becanus, who was nearly nine feet high; a man almost ten feet, and a woman quite ten feet. Among our own countrymen may be named Walter Parsons, porter to king James the first, about seven feet seven inches in stature; and Edward Malone (or Melloon), whom Dr. Molyneux and Dr. Musgrave have described, of the same height, A. D. 1682—5. In the forty-first and forty-second volumes of the Philosophical Transactions are two engravings taken from an os frontis and an os bregmatis, the former of which is reckoned to have belonged to a person between eleven and twelve feet high, the other to a giant of thirteen feet four inches; but no history is given of the other bones of these skeletons. The Chinese pretend to have had men among them even so prodigious as fifteen feet high! Perhaps these relations are no better founded than their chronological fables. However, I now shall subjoin a short account of Mr. O'Brien, the Irishman who has lately been exhibited in London, and who pretends, in his printed advertisements, to be nearly *nine feet high*.

I visited this Irishman on the fifth of May, 1804, at No. 11, Haymarket: he was of a very extraordinary stature, but not

not well formed. As he would not suffer a minute examination to be made of his person, it is impossible to give any other than a very slight description of him. He declined the proposal of walking across the room, and I believe was afraid of discovering his extreme imbecility. He had the general aspect of a weak and unreflecting person, with an uncommonly low forehead; for, as near as I could ascertain, the space above his eye-brows, in a perpendicular line to the top of his head, did not exceed two inches. He told me his age was thirty-eight years, and that most of his ancestors, by his mother's side, were very large persons. The disproportionate size of his hands struck me with surprise, and in this he seemed to make his principal boast. He refused to allow a cast to be made of his hand, and said it had been done many years ago: but as I have seen that cast at Mr. Bacon's, I am convinced the size is much too small to represent his present state of growth. All his joints were large, and perhaps rickety; his legs appeared swollen, misshapen, and, I thought, dropsical: however, he did not like my touching them. The feet were clumsy, and concealed as much as possible by high shoes. His limbs were not very stout, especially his arms, and I judged that he had scarcely got the use of them; for, in order to lift up his hand, he seemed obliged to swing the whole arm, as if he had no power of raising it by the action of the deltoid muscle. He certainly had a greater redundance of bone than of muscle, and gave me the impression of a huge, overgrown, sickly boy; his voice being rather feeble as well as his bodily energies, and his age appearing under that which he affirmed. Indeed I find he gave a different account of himself to different visitors. The state of his pulse agreed with the general appearance of his person, viz. feeble, languid, and slow in its motions. With regard to his actual height, I felt anxious to detect the fallacy he held out of its being *almost nine feet!* Upon extending my arm to the utmost, I reached his eye-brow with my little finger; allowing his height to have been two inches and a quarter above this, it could not be more in the whole than seven feet ten inches; so that I am persuaded the common opinion, founded on the giant's own tale, is greatly exaggerated.

LXIII. *Copy of a Letter from Mr.* Cuthbertson *to Dr.* Pearson, *communicating an important and curious distinguishing Property between the Galvanic and Electric Fluids**.

DEAR SIR,

I think it right to inform you, that yesterday evening I resumed the experiments with the Galvanic batteries. The result was:

1. Charcoal was deflagrated and ignited for above an inch in length.

2. Iron wire, 1-40th inch diameter, was melted into a ball 1-16th inch diameter.

3. Platina wire, 1-100th inch diameter, was melted into a ball 1-10th inch diameter.

4. Brass wire, 1-20th inch diameter, 3-4th inch in length, was ignited.

5. Brass wire, 1-16th inch diameter, was red hot at the end.

6. Iron wire, 1-150th inch diameter, was red hot for sixteen inches in length.

7. Iron wire, twelve inches, deflagrated, and melted into a ball.

8. Iron wire, six inches in length, was deflagrated.

9. Iron wire, eight inches in length, was ignited.

Two troughs, each trough containing thirty pairs of plates six inches square, were used for the first seven experiments, and one of these troughs only for the two last experiments.

The four last experiments prove, I think, that *double quantities of Galvanic fluid only burn double lengths of wire, and not the square, as electrical discharges do.*

I am with the greatest respect, sir,
Your very humble servant,
John Cuthbertson.

Poland-street, Soho,
27th March, 1804.

LXIV. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF GOTTINGEN.

The physical class has proposed the following prize question for the month of November, 1805:

Quum physiologi de vasculoso vegetabilium contextu diversa prorsus statuant, aliis, iisque antiquioribus, illum ad-

* Communicated by Dr. Pearson.

serentibus,

serentibus, recentioribus contra in alia omnia euntibus; novis experimentis, ope *microscopii compositi* curate instituendis, elici probarique cupit Societas: utrum omnino a Malpighii, Grewii, du Hamelii, Mustelii, Hedwigiique observationibus ac placitis standum sit, an vegetabilium natura ab animali fabrica prorsus differat, omninoque vel fibrarum fibrillarumque, quæ Medici est sententia, vel cellularum ac tubulorum *(tissu tubulaire)* contextu ac structura contineatur.

"As physiologists have been of different and opposite opinions respecting the vascular structure of vegetables, the more antient maintaining, whilst some modern have denied, its existence; the society are desirous that new microscopical experiments should be instituted, in order to decide by them, whether the observations of Malpighi, Grew, Duhamel, Mustel, and Hedwig, be well founded, or whether the structure of vegetables be different in its nature from that of animals, and composed of a peculiar and more simple organization; consisting, according to the opinion of Casimir Medicus, of fibres and fibrils; or, according to that of Mirbel, of cellular and tubular texture (*tissu tubulaire*)."

At the same time regard is to be had to the following subordinate queries:—1. How many sorts of vessels can be with certainty assumed from the first period of developement of the plant? and, in case they really exist,—2. Are those vessels which are called spiral (*vasa spiralia*) themselves hollow? or do they serve to form proper canals by their spiral turns? and, 3. How do both the fluids and gases move in them? 4. Do, according to Sprengel, the spurious tracheæ *(treppen-gänge)* originate from the coalition of these spiral fibres? or, on the contrary, according to Mirbel, do the latter take their origin from the former? 5. Do the alburnum (*l'aubier*) and ligneous fibres originate from the spurious tracheæ; or rather from original and peculiar vessels, or from a vascular texture?

The premium is fifty ducats, and the latest period for receiving the observations is before the end of September 1805.

ORIGINAL VACCINE POCK INSTITUTION.

On Monday April 30th ult. there was a most respectable and agreeable annual meeting of the governors of this Institution, established January 1800. Before dinner the earl of Cholmondeley, the president, being in the chair, the continuation of the report was read, of the investigation of the

the laws of agency of the vaccine pock matter, and of the practice and proceedings of the institution, as written by the physicians Drs. Pearson, Nikell and Nelson. The necessity of such inquiries will be understood by all who are aware how little was known on the first promulgation of the cow pock inoculation in 1798; and of course how many errors must have been committed in the subsequent practice. The rude state in the first three or four years is clearly exposed by the report published in a former year, and is again exposed by the numerous additional facts related in the one read the other day. Among other resolutions, were—

1. That the thanks of the meeting be given to Drs. Pearson, Nikell, and Nelson, for their able report.

2. That this report be printed under their direction.

3. That the thanks of this meeting be given to the whole of the Medical Establishment for their gratuitous * services.

Till the report be printed, it may be interesting to our readers to lay before them an extract relating to the effect of the new inoculation, in diminishing the mortality of the small pox, concerning which such contrary statements have been published by persons either unacquainted with the facts, or from motives of self-interest.

One of the objects of this institution has been to furnish instructions for the vaccine practice; and this has been done by showing patients to visitors and students, as well as by public lectures; and also by written and printed papers. It has accordingly disseminated the new inoculation through many parts of the world. By this time its instructions and matter have introduced the vaccine inoculation into New South Wales, as it did before at Paris, Vienna, &c. &c. It may be expected from the extensive practice of vaccination, (this institution alone having vaccinated, and been the immediate means of vaccinating, 60,000 persons.) that the fatality of the small pox must have been diminished. That diminution, however, does not yet appear; for the bill of mortality for London reports 1202 to have died in the year 1803, whereas 1111 died in 1799, 522 only in 1797, and 1040 in 1795: and although the number has been greater in the intermediate years, yet still the last year 1202 is not much less than the mean number for each year during any five years for half a century past.—How it has happened that no diminution of mortality

* Not one of the medical officers receives any pecuniary reward: on the contrary, they are all among the most liberal subscribers, from themselves and from their immediate friends, as appears by their printed list.

mortality is yet perceived, may easily be understood, when it is considered that the persons inoculated for the cow pock are chiefly those who would have been inoculated for the small pox; and therefore the same proportion remained for the natural small pox. Hence, hitherto, vaccine inoculation, like the small pox inoculation, is only a benefit to individuals; but that benefit is very much greater than the variolous inoculation, although the variolous inoculation, by preventing the natural small pox, was, till the vaccine inoculation, the greatest benefit in physic. Prejudice, indolence, ignorance, want of opportunities, still occasion inoculation of either kind to be but partially adopted by society at large. How far laws might be established, or means be found out, for every person within a certain period after birth being inoculated, cannot be discussed on this occasion, however important the question may be for the legislature.

After dinner, the president being obliged to attend the house of peers, the following statement was delivered by the right honourable lord Petre, one of the vice-presidents :—

"The grand object of this institution, on its establishment a little more than four years ago, was, to extinguish the small pox, by substituting for it the inoculation of the cow pock : but however great the obligations of the public were to Dr. Jenner, the promulgater of the leading practical fact in 1798, to Dr. Pearson, also in 1798, and to Dr. Woodville, in 1799, for their investigation to justify the new inoculation, still a professed institution was wanting in order to,

"I. Extend by gratuitous inoculation the history of the vaccine pock, of which, comparatively, but little was still known.

"II. To diffuse the knowledge of the new practice.

"III. To preserve a succession of patients for matter for the use of the public.

"To what extent the first of these designs has been executed may be judged from the report published in a former year, and from the papers distributed containing directions for inoculation; and will be judged of further by the report this day read, and ordered to be printed.

"With regard to the second part of the plan, *the diffusing the knowledge of the new inoculation*; the practice has been publicly carried on twice a week since January 1800, at which a great number of practitioners and many students have been present for instruction.

"Institutions confessedly upon a similar plan have been established

established in other places, and instructions for the practice have been disseminated in every quarter of the world.

"With regard to the third part of the plan, *the succession and the supply of matter;* as might be supposed, the numbers inoculated in the years 1800 and 1801 were not considerable. However, a register has been kept, and more or fewer cases have been registered twice a week from January 1800 up to the present time; thereby affording a body of evidence of very nearly two thousand patients, which have been subjects of observation during this space of time. Such a long and uninterrupted course of observation we apprehend has no where else been pursued. The advantages for observation of even half a dozen patients a week, from 200 to 220 weeks successively, over any greater than the total number here inoculated but in a few months or a few weeks, can be well conceived by those who have ever been employed in observation, and need not be explained.

"It appears that not less than 12,000 parcels of matter have been furnished by this institution; and thereby it is estimated fairly, that not fewer than 60,000 persons have been vaccinated with matter directly from this institution; besides incalculable numbers from those so vaccinated.

"The whole pecuniary expense for these benefits amounts to little more than three hundred pounds per annum: and although the subscriptions are voluntary, and mostly of small annual sums; and although the institution has sustained great expenses, and pecuniary losses, chiefly from unfortunately parting with money on a loan, and from being obliged to change their house for the practice; yet there is a surplus of 550l. stock in the funds, and a respectable balance in the hands of the banker: and what is surprising, is, that many persons have received rewards to submit to the test of small pox inoculation, and others have been relieved who were in distressed circumstances.

"We apprehend there is not to be found in the conduct of any other institution, an example of even nearly so much benefit to individuals in particular, and society at large, at so small an expense. However, although it be very true, that provided the present subscribers be permament, the income will be adequate to the present expenditure, it is not to be dissembled that the practice and inquiry might be conducted upon a larger scale, and more agreeably to the different officers, if their income would allow it. Accordingly, although it is not the plan of this meeting to canvass for subscriptions, it is hoped that its friends will thereby be augmented in such a manner as is thought pro-

per;

per; the public having already had an earnest, that their benefactions will be œconomically yet efficaciously employed by the present managers."

ROYAL JENNERIAN SOCIETY.

On Thursday the 17th of May, the anniversary of the institution of this society was celebrated at the Crown and Anchor Tavern, in the Strand. His grace the duke of Bedford was in the chair.

After dinner was over, the health of the king, &c. drank, Mr. Benjamin Travers rose and stated the progress of the vaccine inoculation. He mentioned, that for ten years previous to the year 1802, the annual average of deaths by the small pox, within the bills of mortality of London, were at the rate of 1850, and that within the last year the deaths had not amounted to 1000. The expenses of this society, in the establishment of a central and other houses for the purposes of the institution, amounted to a considerable sum in the first instance, and would annually require the expenditure of 1000l.; to provide for which, the trustees at present had only a fund of 400l. a year in the stocks and in subscriptions. After describing the salutary influence of the discovery of Dr. Jenner in other countries, and particularly in the East Indies, Mr. Travers read over the names of the different subscribers, and delivered an interesting and forcible appeal to the feelings of the company, to excite them to use their utmost endeavours to augment the resources and propagate the views of the society. He concluded by paying a very handsome compliment to Dr. Jenner, whose name he observed would flourish when nations yet unborn would be forgotten.

Exegit monumentum ære perennius.

Several persons bore testimony to the efficacy of the vaccine inoculation, in preventing the propagation of the small pox; among whom were Dr. Ring and Mr. Rowland Hill. The latter stated that he himself, according to the directions of Dr. Jenner, had inoculated above 1600 persons within the last year, and that the effects desired had been produced upon the whole. Nothing, he said, could be more simple than the operation, which he was convinced did not even require the interposition of any medical gentleman in the first instance: but should such interposition be afterwards required, which he did not think likely, he was sure none of the honourable profession would hesitate to afford such assistance to the poor *gratis*.

 In

In the course of the evening, Dr. Letsom apologized for the absence of Dr. Jenner, who was prevented from attending by indisposition.

ROYAL ACADEMY.

The exhibition of this year is, upon the whole, highly creditable to the artists of Great Britain. It is true, that in the higher walk of painting the specimens are not numerous: that deficiency is not, however, to be attributed to want of talent in the painters of our country: at different times they have evinced, that if proper encouragement were given, we have more than one artist capable of rising to excellence as an historical painter. This is not the place to point out the causes of this want of encouragement, which damps the ardour of British genius, and compels it to "skim the midway air," while it feels all the energy which the boldest flight demands. That ardour the artist is forced to restrain; for it requires no great discernment, nor length of time, to discover that a man may exist without *fame*, though he cannot without *bread*, and he is aware that he has a chance to paint a thousand portraits before he can find *one* employer for *one* historical composition. What follows? He must *eat*, and therefore must paint *portraits*.

We have observed for many years past, that attempts have been made by several individuals of the British school, at what may be termed, in this political age, a *coalition* between history- and portrait-painting. Of this attempt, when kept within proper bounds, we highly approve. Sir J. Reynolds was often successful in this way. He possessed an elegance of mind, a delicacy of taste, and soundness of judgment, which rendered this attempt successful in his hands. He did not, if we remember well, carry this coalition beyond one or two figures. Others followed him in this line with more or less success; but, if we are not mistaken, those productions which have exhibited a *mob* of portraits on the historical canvass, though they have generally succeeded as to *profit*, have not obtained the *approbation* of the true connoisseur. Fettered by the unpicturesque lines of modern dress, and pestered by every person he was to represent, to make him a prominent figure in the picture, the artist was obliged to sacrifice every rule of composition, and succeeded accordingly. From this general censure we must except The Death of Wolfe, by Mr. West.

We now pass to a few observations on the pictures of this year.

The President, No. 30. *Destruction of the Beast and false*

false Prophet.—This extensive composition is a work of great merit. The union of effect, in spite of the heterogeneous parts of which it is formed, deserves high praise. The principal figure is however defective both in dignity and beauty.

Mr. Westall, No. 23. *Henry III. replying to the Bishops.*—This subject, which is not an easy one, is well treated. The artist has given that variety of character to his ecclesiastics, which preserves the picture from monotony. They all feel abashed and disappointed, but each feels according to his peculiar character. Had there been more of sarcasm thrown into the face of the king, it would have improved the picture. This, though not suited to his general character, certainly suited the occasion. The composition is simple and chaste, and there is a richness and sobriety in the colouring, with much depth of tone.

Among the drawings by Mr. Westall, are four portraits, which, coming from an artist hitherto employed in the higher walks of the art, may perhaps be justly esteemed the greatest *novelty* of the present exhibition. The subjects are all highly favourable, and the artist has diversified the scenery so as to give each of the drawings a character peculiarly its own.—No. 363, Portrait of Miss Bennet, is distinguished by the beauty and elegance of the figure, and the luxuriance of the landscape.—No. 368, Portrait of Miss Esten, as Una, strikes by the patient gentleness of the figure, opposed to the fierce watchfulness of the lion, and the rugged grandeur of the forest scene.—No. 374, Portrait of Mrs. Esten. This drawing is characterized by the gracefulness of the figure, and the rich sobriety of the landscape.—No. 377, Portrait of Miss Hamilton. There is an infantine simplicity mixed with great archness in the figure; and the landscape, which is of the park kind, unites the charms of simple and cultivated nature. The colouring of each of the drawings is as distinct as the design, and is admirably suited to the different subjects.

As our artists are condemned to make *portrait* their chief object, it gives us pleasure to see that Mr. Westall has joined the *coalition* we before mentioned in our critique, as we hope for a continued gratification in *this kind* from his pencil. His *portraits*, independent of correct and graceful resemblance, are viewed with satisfaction as *pictures* by the eye of taste.

Mr. Opie, No. 71. *Gil Blas taking the Key from Dame Leonora.*—Beautiful in effect, but truth is sacrificed to produce it. The intended source of light is the torch held

by

by the young woman, but no part of the picture is illuminated by this torch. The head of the old woman is very fine, that of the young one is beautiful, and her figure extremely graceful. The composition of the whole is in the best manner of this master.

Mr. Farrington, No. 81. *View of Edinburgh.*—This is certainly the best picture of this artist in the present exhibition. The scene is well selected, and painted with great truth and delicacy. The hues are of that mild and unassuming kind which charm so much in nature, and are so seldom seen in art.

Mr. Lawrence, No. 25. The face of the lady (*Mrs. Williams*) is a beautiful representation of a beautiful subject, but the arm and some other parts of the picture appear unfinished. The portrait of Mr. Kemble, No. 110, is a very fine portrait, and a striking likeness. Mrs. Siddons, No. 193, is, we think, intended to be in the historic style. There is much grandeur in it; and though it do not possess all the feminine grace we could wish, it may perhaps be considered as the best female portrait in the room.

Sir William Beechey, No. 111. *A Child gathering Shells.*—As grandeur of effect was the object of Mr. Lawrence in his portrait of Mrs. Siddons, here the painter was to endeavour to excite pleasing sensations. In this he has succeeded. The picture is painted with much delicacy, and the accompaniments contribute to impress the pleasing sensations which the painter intended should be excited. The placid delight of the child in her occupations, as expressed by the artist, must give us a high opinion of his conceptions and execution.

Mr. Thomson, No. 151. *Shipwrecked Mariner.*—A well-coloured picture. The figure not original, but judiciously applied. According to the quotation, he ought to be turned *to* the setting sun; but he is turned *from* it. The sun is setting in the back-ground of the picture, and the figure is illuminated by some other, and some greater light.

Mr. Owen, No. 198. *Beggars.*—An admirably coloured picture, and designed with great simplicity: but the point of sight is not chosen with judgment, it being placed so low, that the eye of the person of whom they are supposed to be asking charity, must be on a line with the knee of the child; which could not be the case, unless the top of a wall had been selected as the best place to beg from.

Mr. Turner, No. 183. *Boats carrying out Anchors, &c.*—

A picture

A picture of very great merit, mixed with some defects. The principal beauty of the work is the boatful of figures, admirably coloured, and the water immediately around it, which is painted with a freedom and transparency of the most perfect kind.—Of the Narcissus and Echo by the same artist, we cannot speak in terms of such high praise. The parts are small; and the whole, though well coloured, is without that vigour which has been the general character of his works.—The best of his productions this year is the drawing, No. 373, Edinburgh, from the Caltoun Hill. Perhaps in richness, variety, and truth of colour, it may justly be preferred to any thing he ever exhibited.

On a future day, if we can find time and room, we shall resume our critique.

LXV. *Intelligence and Miscellaneous Articles.*

TYPOGRAPHIC ART IN TURKEY.

A LETTER from Constantinople, dated the 27th of February, states that typography begins to make some progress in that city. An edition of the Mussulman catechism, forming an octavo volume of eighty-six pages, has just come from the press: it was printed under the inspection of Abdorahman-Effendi, director of the royal printing-office. It appears in general that the situation of copyist, the members of which are very numerous, will soon be as bad at Constantinople as it must have been at Rome or at Paris in the fifteenth century: one of their most lucrative occupations was a kind of almanac of the Ramazan, which appears annually, with calculations, by the astronomers of the court, indicating for each day the hours of fasting and prayer. The scrupulous exactness of good Mahometans, in observing their Lent, procured to the copyists the sale of many thousands of these almanacs, which were rendered more or less valuable according to their calligraphic merit, and the number of ornaments with which they were embellished. This branch of industry, however, has been almost entirely destroyed since the last year. An almanac of the Ramazan has been printed at Scutari on Italian paper which resembles parchment: it contains for each day the hour and minute at which fasting ought to be begun; the length of each night during which it is allowed to Mussulmans to give themselves up to the pleasures of sense; and, by

by way of supplement, as in the almanac of Liege, the days for bleeding, taking physic, applying cupping-glasses, &c.

This innovation may appear to the Europeans of very little importance; but it displays boldness in the Turkish government, which wishes by these means to sound the sentiments of the people, who dislike every novelty. It has completely succeeded: the copyists only are allowed to murmur; but the indigent devotee is very glad to procure his almanac cheaper. Government have taken advantage of this good disposition, and calendars for the whole year are now printed. If any philosopher should smile at the honourable mention which I here make of the first fruits of the Turkish typography, let him only consult the list of the first works printed in Germany by Guttenberg and his associates, and at Paris by Ulric Gering, who was invited thither by the Sorbonne. Other productions, which do more honour to the choice of Abdorahman-Effendi, might be mentioned; such as the Annals of the Reign of Abdul-Hamet, which are in the press, and Faden's Atlas, which he caused to been graved and printed last summer. The impression and engraving indeed are inferior to those of the maps of Ibrahim-Effendi, published in the last century; but geographical knowledge is not wanting at Constantinople; and major Rennel has obtained from it very valuable information for the two large maps of Asia, on which he has been employed these two years.

ANTIQUITIES.

In digging the canal of Aiguemortes at Beaucaire, tombs, earthen vases, and copper rings of great antiquity have been discovered. These tombs, which are at the distance of about fifteen hundred toises from the present course of the Rhone, consist of large chambers of uncut stones placed vertically, joined to each other without cement or mortar, and covered with stones of the same form. Some of them contain human bones, in such good preservation that the structure of them, with their different laminæ, can be easily distinguished. In some others were found earthen vessels glazed and unglazed, with four handles, in the form of cinerary urns. There were found also some amphoræ, which were employed by the antients for holding wine and for other purposes. These amphoræ contained copper rings, or bracelets, which the antients, and particularly the Gauls, wore on their arms.

DECLINATION OF THE MAGNETIC NEEDLE.

The declination of the needle, which was found at Thoulouse in 1770 to be 18° 59′, and in 1780, 20° 15′, and in 1790, 21° 5′, was observed on the 1st of Germinal, year 12, to be 21° 43′.

TRADE AND COMMERCE.

The Russian minister of commerce at St. Petersburgh, count Rumanzoff, has just caused to be published a collection of twenty-one important tables, which give a correct and comprehensive view of the present state of the Russian commerce with foreign nations. The count, in the introduction, which is written by himself, says: "The results of our trade have hitherto been kept secret; but where the sovereign is the father of his people, what has he to conceal from them? The emperor, therefore, has given orders that the whole commercial system of the kingdom should be communicated to the public." The 11th and 19th tables, which give an account of the gain which Russia makes by the transit trade between Europe and Asia, are particularly worthy of notice. The tables are divided into five parts, which comprehend the trade on the Baltic, the White Sea, the Black Sea, the Caspian Sea, and the inland trade.

	Rubles.
The provisions imported in the Baltic in the year 1802 amounted to	11330595
Exported	7041008
Excess of the imports	4289587
The principal articles imported were	
Sugar	4831311
Wine	2001577
Salt	1318641
Coffee	992138
Those exported	
Rye	4041227
Wheat	1318745
Barley	978107
The metals imported amounted to	486074
The articles were	
Gold and silver in coin and in bars	4000000
The metals exported amounted to	3758040
Among which were	
Iron	3741928
The rest was copper.	

	Rubles.
The raw materials imported amounted to	5743572
Among which were	
Colours - - -	3500000
The raw materials exported amounted to -	30265817
Among which were	
Hemp - - -	9059159
Tallow - - -	8712240
Flax - - -	5583479
Seeds - -	1655139
Hemp oil - - -	1492240
Timber - - -	1142840
Excess of the exports - -	24522245
The manufactured articles imported amounted to	10961133
Among which were	
Cotton articles - - -	3169042
Silk - - -	480861
Iron instruments - -	294468
Sewing needles - -	38274
Manufactured articles exported -	5589720
Among these were	
Linen cloth of different kinds -	3500000
Russia leather - -	1090966
Cordage - -	582847
Tallow candles - -	221593
Furniture - -	16593
Excess of the imports - -	5371413
The whole of the imports in the Baltic amounted to - - -	32983418
The exports - - -	46917134
Excess of the exports - -	13933716
To which must be added four millions in gold and silver coin and bars; so that Russia, by its trade in the Baltic, gains annually eighteen millions of rubles merely in raw materials.	
At Archangel and the other parts of the White Sea the provisions imported amounted to -	387404
Exported - - -	1383142
Of which the corn amounted to -	1350000
The total of the imports in the White Sea -	549732
Exports - - -	4796017
Excess of the exports - - -	4246285

HYDROGRAPHY.

An officer many years in the army in the East Indies, being struck with Mr. Churchman's ideas of reducing to a system

system all the changes of the land gaining on the sea, and the contrary, which are gradually carried on throughout the world, requests us to make known a few facts which correspond with the Asiatic researches. He was acquainted with a lady, who died at Madras in the year 1797 at the advanced age of 96 years, who used to say that the sea had encroached there about three English miles within her remembrance; that some years ago a row of cocoa-nut trees stood at the place where the ships now ride at anchor. From the time he left India in 1794 until his return there in 1799, the sea had encroached so much as to cause the beach-house belonging to the customs, which stood at the south end of the fort, to be removed three miles to the north of it, and that the sea at that place continued to encroach gradually upon the land every year.

ANOTHER STONE FROM THE CLOUDS.

We have been at some pains to obtain correct information respecting this phænomenon, which happened on the 5th of April; and we have been assured by Robert Craufurd, esq. the proprietor of the ground where the stone fell, that the following particulars may be depended on; he himself, with the following gentlemen belonging to the university of Glasgow, viz. Dr. Freer, Dr. Jeffry, Professor Davidson, and Professor M'Turk, having taken considerable pains to have them ascertained.

On the day above mentioned, three men at work in a field at Possil, about three miles north from Glasgow, were alarmed with a singular noise, which they think continued for about two minutes, seeming to proceed from the south-east to the north-west. At first, it appeared to resemble four reports from the firing of cannon, afterwards the sound of a bell, or rather of a gong, with a violently whizzing noise; and lastly they heard a sound as if some hard body struck with very great force the surface of the earth.

On the same day, in the forenoon, sixteen men were at work in the Possil quarry, thirty feet below the surface of the ground, and there too an uncommon noise was heard, which, it is said, seemed at first to proceed from the firing of some cannon; but afterwards the sound of hard substances hurling downwards over stones; and continuing in the whole for about the space of a minute.

By others who were at the quarry, viz. the overseer of the quarry, and a man who was upon a tree, to whom he was giving directions, the noise is described as continuing about two minutes, appearing as if it began in the west, and

passed round by the south, towards the east; at first as if three or four cannon had been fired off, about the great bridge which conducts the Forth and Clyde canal over the river Kelvin, at the distance of a mile and a half westward from the quarry; and afterwards as a violent rushing, whizzing noise. Along with these last people, there were two boys, one of ten, and the other of four years old, and a dog: the dog, on hearing the noise, ran home seemingly in a great fright. The overseer, during the continuance of the noise, on looking up to the atmosphere, observed in it a misty commotion, which occasioned in him a considerable alarm; when he called out to the man on the tree, "Come down, I think there is some judgment coming upon us;" and says, that the man on the tree had scarcely got upon the ground, when something struck with great force, in a drain made for turning off water, in the time of, or after rain, about ninety yards distance, splashing mud and water for about twenty feet round. The elder boy, led by the noise to look up to the atmosphere, says, that he observed the appearance of smoke in it, with something of a reddish colour moving rapidly through the air, from the west, till it fell on the ground. The younger boy, at the instant before the stroke against the earth was heard, called out, "Oh such a *reek!*" and says, that he then saw an appearance of smoke near the place where the body fell on the ground. The overseer immediately ran up to the place where the splashing was observed, when he saw a hole made at the bottom of the drain. In that place a small stream of water, perhaps about a quarter of an inch deep, was running over a gentle declivity, and no spring is near it. The hole was filling with water, and about six inches of it remained still empty. The overseer, having made bare his arm, thrust his hand and arm into the hole, which he judges to have been almost perpendicular, the bottom being perhaps rather a very little inclined to the east, and the upper part of it to the west: at the bottom of the whole he felt something hard, which he could not move with his hand. The hole was then cleared out, with a shovel and mattock, from an expectation that a cannon ball might be found; but nothing was observed except the natural stratum of soil, and a soft sandy rock upon which it lay, and two pieces of stone, that had penetrated a few inches through the rock. The pieces of stone he took to be whinstone, and thinks that they were eighteen inches below the bottom of the drain, and that the hole was about fifteen inches in diameter. He was not sensible of any particular heat in the water, or in

4 the

the pieces of stone, nor of any uncommon smell in the latter, although he applied them to his nostrils. He says, that the one piece of stone was about two inches long; that the other piece was about six inches long, four inches broad, and four inches thick, blunted at the edges and end; that the fractures of these pieces exactly coincided; that he does not know whether the fracture was caused by the violence of the fall, or by the mattock; and that he never saw any such stone about the quarry.

Some days after, when the particulars which have been narrated, became known, a careful search was made for these pieces of stone, which had been disregarded, and the first-mentioned piece was soon found; but the largest piece having been used as a block in the quarry, and having fallen among rubbish, could not be discovered. Some days after, a fragment of it was detected. The two fragments recovered make the two extremes of the stone: on the surface they are pretty smooth, and of a black colour; but internally they have a grayish appearance. The intermediate part, larger than both, seems as yet to be lost.

At the village of High Possil, which is within a quarter of a mile of the place where the stone fell, the noise gave much alarm to those who were in the open air; and there, it seems, they thought that the sounds proceeded from south-east to north-west, agreeably to the report of the three men first mentioned.

Two men at work within a hundred yards of the house of Possil were alarmed by the noise; they thought it over their heads, and that it resembled the report of a cannon, six times repeated, at equal intervals, with a confused uncommon sound of ten minutes duration: the noise seemed to begin in the north, and to turn round by the west, south and east to the north.

The day was cold and cloudy; a little more cloudy in the north-east than in the other quarters.

It may be proper to remark, though the overseer did not observe the pieces of the stone to have any peculiar smell when he took them out, that when Mr. Craufurd obtained the first piece, it had a fishy and fœtid smell, and that he noticed the second also to have the same flavour, but in a less degree. Another circumstance also deserves particular notice, because, coming from children, they could not possibly adapt their tale to the circumstances required by the nature of the phænomenon, and it therefore demands the more implicit credit. The eldest boy says he saw the smoke moving very

 quick

quick to the place where the stone fell, and something red in the smoke, and that *the foremost part of the red substance was reddest*; which is exactly what might be expected to be the appearance, if the body was in a state of incandescence. The only thing singular in this case, if the boy was not deceived in what he believed himself to have seen, is, that the stone should have cooled so rapidly, even in water, as not to be sensibly hot to the touch when the overseer of the quarry thrust his arm into the hole which had been made by it.

About the time when the above phænomenon took place, a noise was heard in the air, at places at a considerable distance from where the stone fell. A person walking in his garden at Barnhill, Blantyre, nine miles south-east from Glasgow, heard five or six distinct reports as if from artillery, after which there were several though not loud peals of thunder, accompanied with some flashes of lightning. A somewhat similar noise was heard at the same time near Airdrie, eleven miles east from Glasgow; at Falkirk, which is twice the distance, in nearly the same direction; at Hamilton, eleven miles to the south, and at many other places.

VELOCITY OF THE GALVANIC FLUID.

Vassali-Eandi has lately made some experiments on this subject, as Beccaria did in regard to the velocity of the electric fluid. The fluid of a pile of twenty-five pairs of plates traversed in a second thirteen metres (forty-two feet and a half) of gold cord. In another experiment with a pile of fifty pairs, the fluid passed along a copper wire plated with silver, three hundred and fifty-four metres (1151 feet) in length, in a time incommensurable: the shock in this case was three times as strong as that experienced by immediately touching the two extremities of the pile.

ACID FUMIGATIONS FOR INFECTED CATTLE.

T. Rasori has lately communicated to M. Guyton Morveau the result of some experiments made with acid fumigations to destroy contagious diseases among cattle. Six oxen, which had for several days been attacked by an epizootic fever, died, though acid fumigations were employed. A cow was confined in a cow-house, where their straw and even the body of one of them had been left, and continued there forty days, during which fumigations with oxymuriatic acid gas were regularly made. The cow remained in good health,

health, and showed no symptoms of disease. Sixty-two oxen, all evidently diseased, and of which eight were almost dying, were shut up in two cow-houses where similar fumigations were made: fifty-two of them were perfectly cured, though housed with the infected cattle. The author asks, whether they might not have been cured without the use of the fumigations?

PETRIFACTION.

A very curious petrifaction was found lately at Vaucelles, in the department du Nord. A workman, in attempting to square a stone obtained by demolishing the abbey of Vaucelles, split it into two parts; one of which exhibited the impression of a fish, and the other the fish in relief. The fish was examined by the professors of the college of Cambray, who repaired on purpose to the spot. It results from their observations, that it is one of the most beautiful and best preserved ichthyolites ever found. It is from twenty-eight to thirty-one inches in length, and seven inches in breadth. Every thing gives reason to think that it belongs to the class of the abdominals, and that it is a salmon. The scales are of a violet colour mixed with yellow: a lateral line of a pale white, and nearer the back than the belly, traverses the whole body, and describes on it a curve. The colours of the impression are the same as those on the relief.

It has been ascertained that this stone was originally dug up from a quarry in the neighbourhood, but long since neglected. The proprietor of this natural curiosity has made a present of it to the museum of Cambray, but on condition of its not being given to any other museum.

ARTS AND SCIENCES IN SPAIN.

The amateurs of foreign literature will learn with pleasure, that a new journal has been published at Madrid, under the title of Miscellanies in the Sciences, Literature, and the Arts. The subjects which form the object of this journal are divided into five parts:—1st, The physical and mathematical sciences, and the application of them to useful purposes: 2d, Natural history: 3d, Agriculture, medicine, and the arts of industry: 4th, The different branches of literature: 5th, The fine arts. Besides original pieces and translations from foreign works, which will form the principal part of the journal. Each number is to contain

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an analysis of, and extracts from, Spanish and other works, but chiefly the former. A number appears on the 1st and 15th of each month, consisting of two sheets octavo, price eighteen rials per quarter. The first number was published January 1st, 1804.

LECTURES.

On Monday, June 4th, a course of lectures on physic and chemistry will recommence at the Laboratory, Whitcomb-street, Leicester-square, at the usual morning hours, viz. the *Therapeutics* at a quarter before eight, the *Practice of Physic* at half after eight, and the *Chemistry* at a quarter after nine; by George Pearson, M.D. F.R.S., Senior Physician to St. George's Hospital, of the College of Physicians, &c. &c.

A register is kept of Dr. Pearson's patients in St. George's Hospital; and an account of them is given at a clinical lecture every Saturday morning at nine o'clock.

The practice of vaccination will be shown, and lectures given as usual, during the summer, at the Institution, No. 44, Broad-street.

At the Theatre of Anatomy, Blenheim-street, Great Marlborough-street, Mr. Brookes will commence his course of lectures on Anatomy, Physiology, and Surgery, on Saturday, the 9th of June, at two o'clock, when the introductory lecture will be delivered.

The course will be continued on Monday the 11th, and every subsequent morning, at seven.

A suite of commodious dissecting-rooms, thoroughly ventilated, will be opened at five, attended by Mr. Brookes. All the subjects will be preserved by an antiseptic process.

Meteoro-

METEOROLOGICAL TABLE*

For May 1804.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Weather.
1804. April 27	51°	59°	50°	29·54	Fair
28	52	59	50	·62	Small rain
29	54	62	54	·91	Fair
30	55	68	58	·86	Fair
May 1	59	70	56	·80	Fair
2	55	67	54	·90	Fair
3	54	70	58	·82	Fair
4	56	66	60	·85	Showery
5	60	72	61	30·08	Fair
6	62	68	59	·20	Cloudy
7	63	70	57	·29	Fair
8	59	63	48	·22	Fair
9	51	60	49	·12	Fair
10	54	64	51	29·91	Fair
11	53	57	44	·92	Showery
12	46	55	49	30·00	Cloudy
13	50	57	50	·08	Fair
14	51	64	54	·08	Fair
15	53	67	55	30·00	Fair
16	56	69	50	29·88	Showery
17	49	65	54	·78	Fair
18	50	64	55	30·00	Cloudy
19	58	68	57	29·75	Fair
20	61	68	53	·78	Fair
21	60	68	55	·80	Fair
22	61	65	52	·80	Small rain
23	55	66	53	30·05	Fair
24	56	63	54	29·60	Rain
25	52	60	54	·75	Cloudy
26	58	66	51	·72	Fair

* By Mr. Carey, of the Strand.

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Botany.

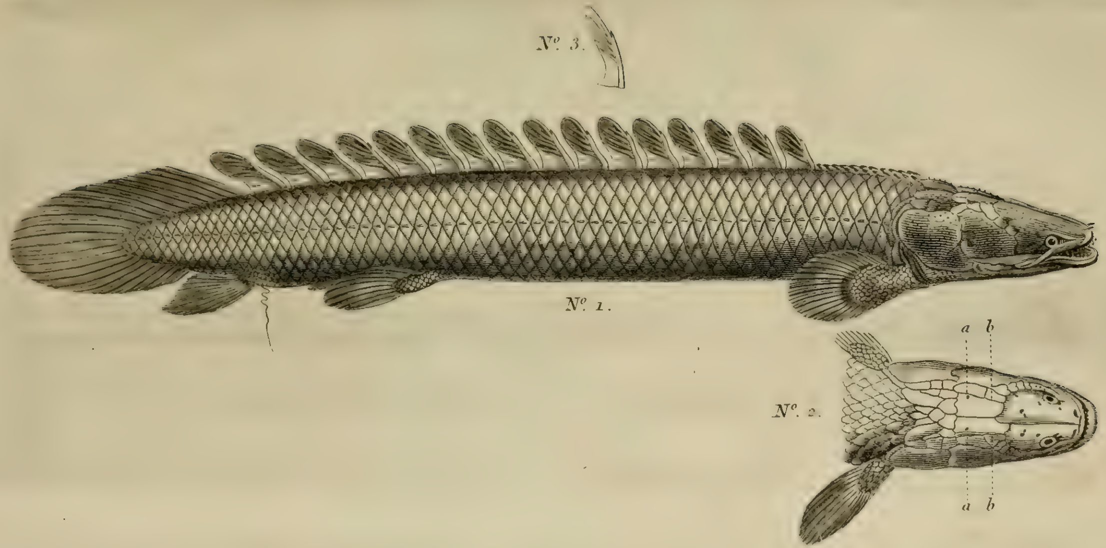
East

Juniper

Newton

END OF THE EIGHTEENTH VOLUME.

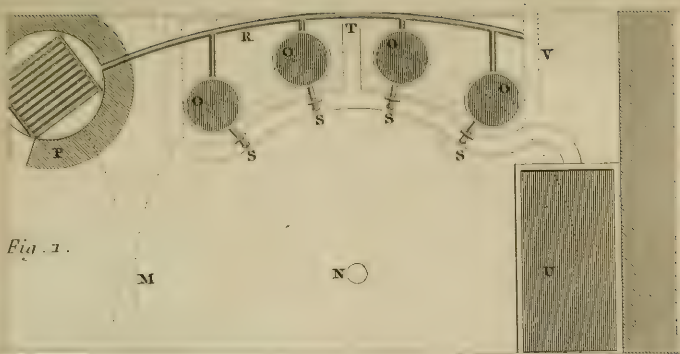
Taylor, Printer, Black-Horse-Court, Fleet-Street.



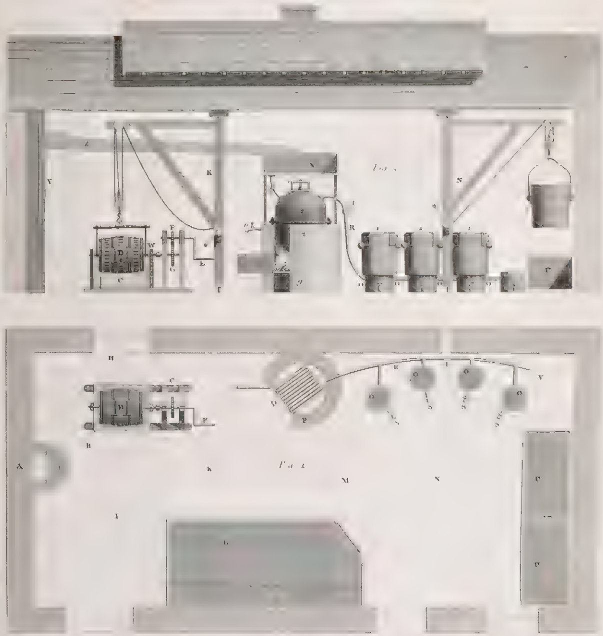
Polyptera Bichir.

Lowry sculp.

Fig. 1.



Elevation & Plan of Mr. Curwen's Steam House for Potatoes



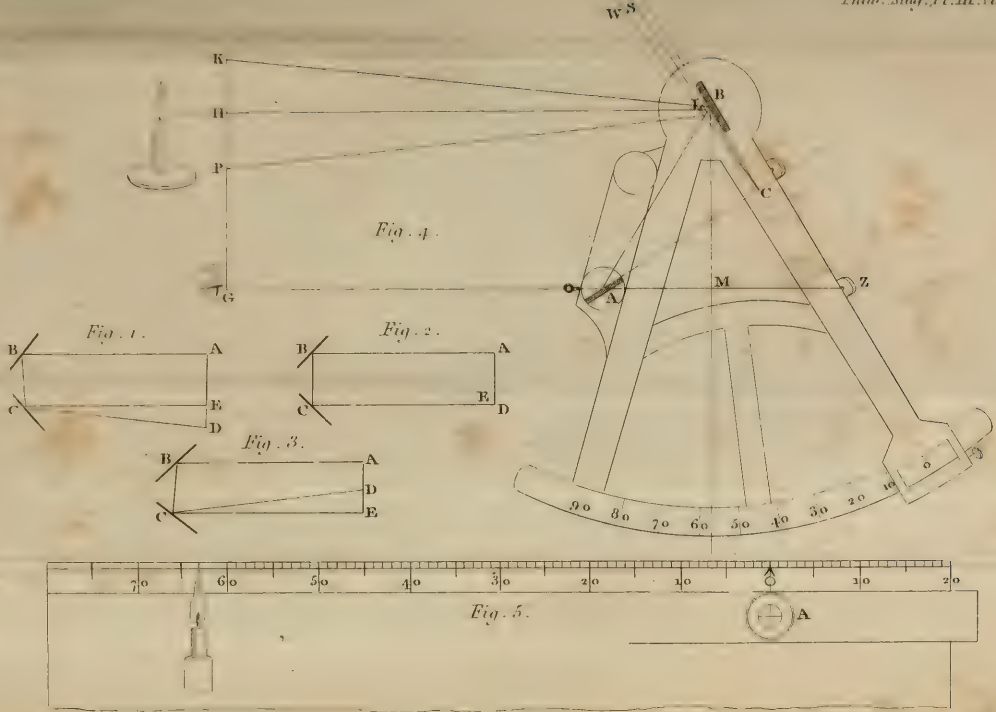
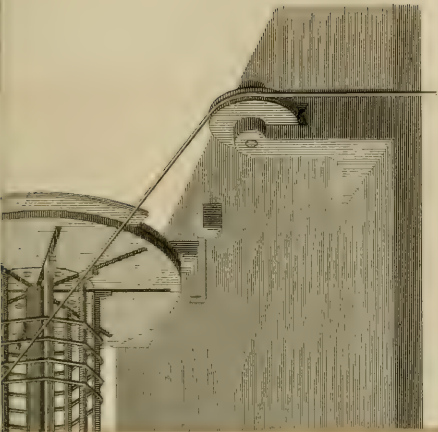
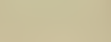


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Lowry sculp

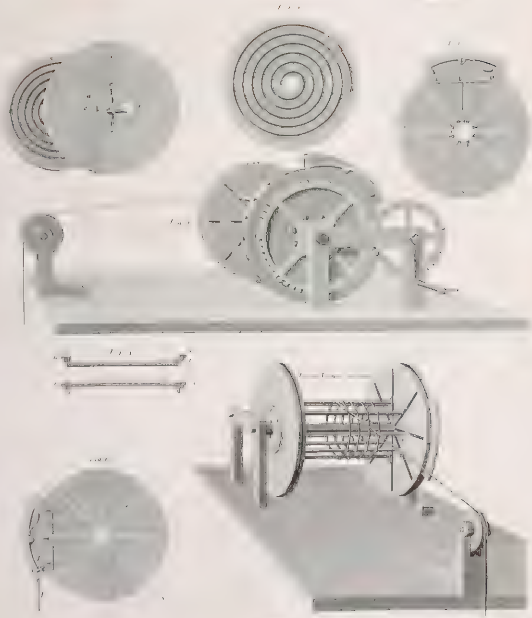


Lowry sculp



Mr. Butlers improved Water Bucket.

Lowry sculp



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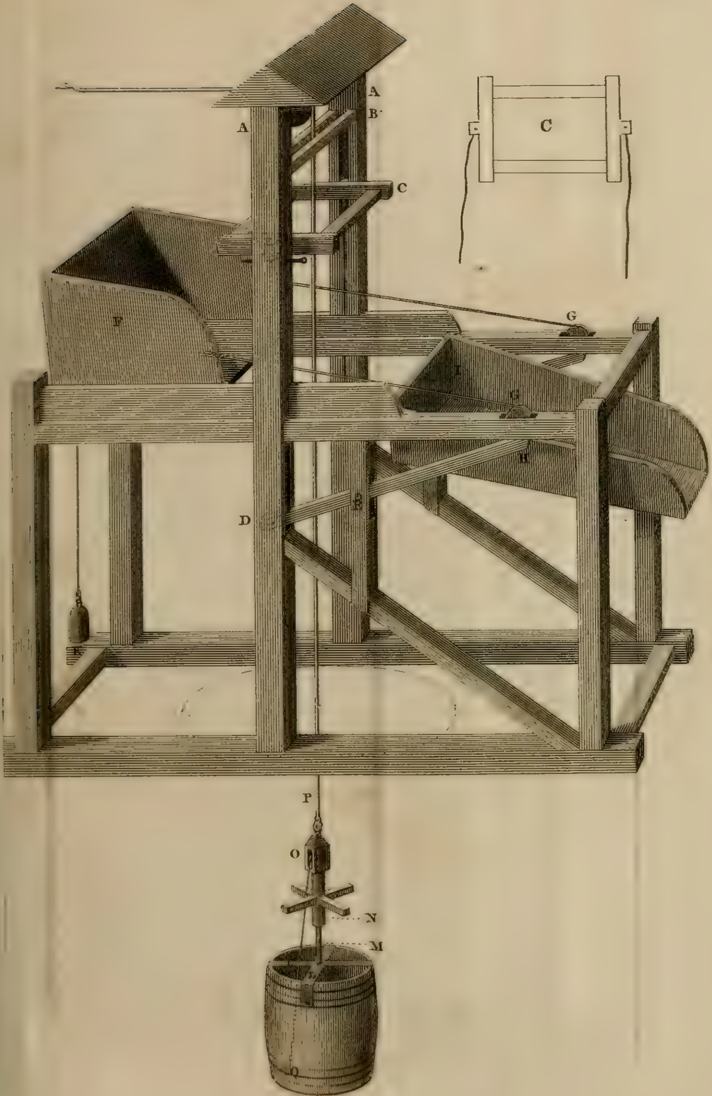
Mr Hall's Expanding Crane



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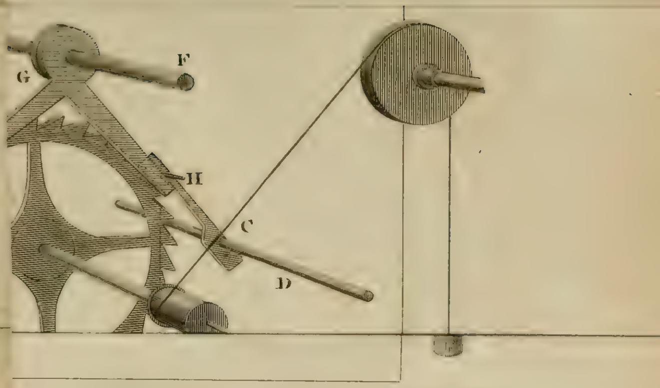
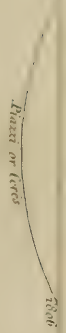
Mr. Butlers improved Water Bucket

Lowry sculp

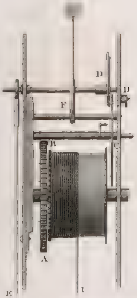


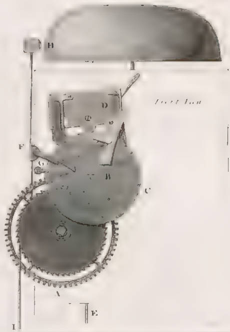
S. Porter sculp.



Phil. Mag. Vol. XVIII. Pl. VI.

Side View





Front View

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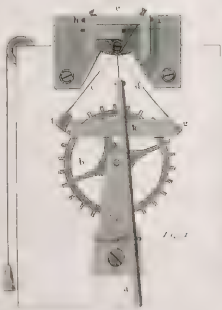

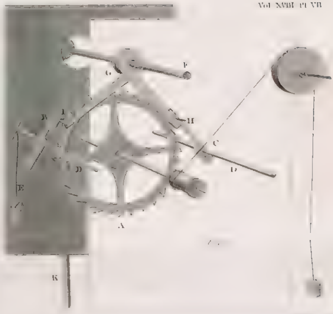

Figure of the Orbits of the two new Planets.